A.M.A.

# Archives OF NEUROLOGY AND PSYCHIATRY

INDEX NUMBER
IN TWO SECTIONS — SECTION I

JUNE 1956

VOLUME 75 NUMBER 6

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*Roy E. McDonald, Robert B. Ellsworth, and Jane Eniss*

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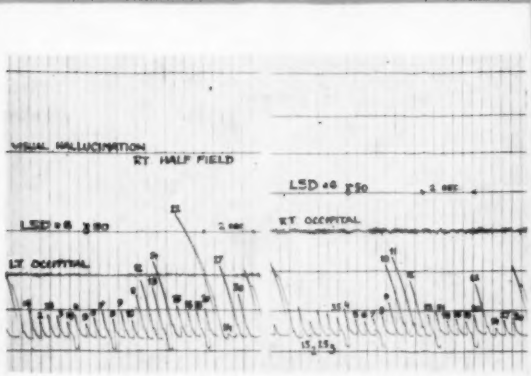


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FOR THE PERIOD
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1. Livingston, S., and Petersen, D.: New England J. Med. *254*:327 (Feb. 16) 1956.
2. Pence, L. M.: Texas State J. Med. *50*:290 (May) 1954.
3. Berman, B. A.: Am. J. Psychiat. *112*:541 (Jan.) 1956.


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1. Fazekas, J.F., et al.: J.A.M.A. **161**:46 (May 5) 1956. 2. Fazekas, J.F., et al.: M. Ann. District of Columbia **25**:67 (Feb.) 1956. 3. Mitchell, E.H.: J.A.M.A. **161**:44 (May 5) 1956.

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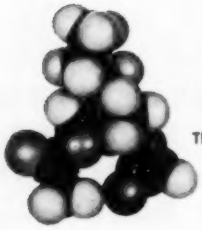

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A.M.A. Archives OF
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# Behavioral Changes of Chronic Schizophrenics in Response to Reserpine

ROY E. McDONALD, M.D.
ROBERT B. ELLSWORTH, Ph.D.
and
JANE ENISS, R.N., Salt Lake City

## PURPOSE OF STUDY

This study has to do with the action of reserpine on the behavior of chronic schizophrenics. It is reported because of the experimental design employed, despite the risk of repeating the conclusions of many similar studies. The study was designed with the thought that only one major variable (reserpine *) was desirable, i. e., that the validity of results should not be lessened by the fact that either the raters who evaluated the behavior change of the patients or the patients themselves had any information concerning the identity of the drug group. For this reason, a double-blind design was used, with adequate experimental and control groups.

Received for publication Nov. 29, 1955.

From the Veterans Administration Hospital, Fort Douglas Division, Salt Lake City.

60 S. 4th E. (Dr. McDonald). Psychologist, Fort Douglas V. A. Hospital (Dr. Ellsworth). Fort Douglas V. A. Hospital (Miss Eniss), in cooperation with those who rated the patients throughout the study: Boyd Oviatt, psychiatric social worker; Richard Osborne and Richard Shepard, aides; Leland Bowles, O. T.; Nick Caputo and Arlie Highes, C. T.; Fred Whitney, recreation; Paul McCullough, psychology trainee.

* Trade name Sandril, supplied by Eli Lilly & Company, Indianapolis.

## PROCEDURE

A ward of 27 chronic schizophrenics, average hospitalization nine years, was selected for study, because as judged both by the estimate of their situation and by testing devices there had been no appreciable change in their behavior in over three to six months. No organic or scheduled psychotherapy had been conducted with this group for over a year; there was a stable ward, personnel, and activity environment. Thirteen patients for the drug and fourteen patients for the placebo group were selected by the toss of a coin on the basis of seating arrangement in the dining room. All four patients at each table received the same medication. Three milligrams of reserpine or a like amount of placebo was placed daily in the coffee or fruit juice by the nurse. She was the only one who knew the identity of the groups, and she did not participate in rating the patients' behavior.

The drug was administered over a 73-day period. The amount accepted by the subjects was from 65% to 100% of that offered, and 80% of the patients accepted at least 85% of their medication.

Behavioral rating scales were devised to cover the patient's behavior in everyday occupational and correctional (exercise) therapy. A previously reported scale, the Hospital Adjustment Scale,[1] was used to evaluate the ward behavior of each patient. The O. T. and C. T. scales were devised to measure possible behavioral improvement in these areas. The usual item analysis and scale-construction methods were used in developing these scales, with an adequate period of training for each rater.

## DRUG TOXICITY

Most evidences of drug toxicity were transient and minimal, having to do with nausea, anorexia, and diarrhea. One patient steadily lost 20 lb. in weight. One patient developed unilateral arm clonus, which disappeared upon withdrawal of the

drug; no evidence of organicity was noted in a full neurological study.

## RESULTS

Table 1 presents the record of significant changes in the patient's behavior for each patient who participated in the study. It is to be emphasized that only definite behavior changes are recorded under the H. A. S., O. T., and C. T. (columns 1, 2, and 3 respectively). Calculation of behavioral changes on the rating scales was completed before anyone knew the identity of the patients in the experimental (drug) group. The following procedure was used to determine whether or not a definite change had occurred:

1. The same rater rated the same patient each month throughout the study.

2. A base-line score was established for each patient at the beginning of the study, and it was assumed that any change in score from this base line could indicate error on the part of the rater and/or improvement-regression in the patient's behavior.

3. A standard error was, therefore, established for each rater, so that a decision could be made as to whether or not a change in score represented a significant change in the patient's behavior (Table 1).

A plus (+) is recorded for a patient only if the difference in his score at the end of the study and his base-line score is greater than the rater's standard error. Two patients in the control group (21 and 24) and two patients in the experimental group (3 and 8) did not attend O. T. or C. T. activities and were not rated in these areas.

At the end of the study, the entire staff was asked to evaluate (last column) each patient's possible behavioral change. The staff members were asked to report "a change that hits you between the eyes, not one that you have to look for."

If at least 90% of the statements favored a change for the better, and there was no more than one dissenting vote among the 22 people present, a patient received a plus (+) in the "Evaluation" column. This was used as a "check" on the three behavioral scales which were used in actually determining whether or not a patient had improved.

Table 1 indicates that slightly more patients "improved" in the experimental group than in the control group, if any change in any area is accepted as "improvement." If, however, incidences of "improvement" are calculated for those patients changing in two or more areas, then the difference between the two groups is greater. By the exact method of calculation,[2] the difference between the two groups is at the 0.03 level of significance (Table 2).

TABLE 1.—*Significant Changes in Patients' Behavior*

| Experimental Group | | | | | Control Group | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Patient No. | H. A. S. | O. T. | C. T. | Evaluation | Patient No. | H. A. S. | O. T. | C. T. | Evaluation |
| 1 | + | .. | .. | .... | 14 | .. | .. | .. | .... |
| 2 | .. | | | (+) | 15 | .. | .. | .. | .... |
| 3 | + | + | .. | (+) | 16 | .. | .. | + | .... |
| 4 | .. | + | + | (+) | 17 | .. | .. | + | .... |
| 5 | + | .. | + | (+) | 18 | .. | .. | .. | .... |
| 6 | .. | .. | .. | .... | 19 | + | .. | .. | .... |
| 7 | .. | + | .. | .... | 20 | .. | .. | .. | .... |
| 8 | .. | | | .... | 21 | .. | | | (+) |
| 9 | .. | .. | + | .... | 22 | .. | .. | + | (+) |
| 10 | + | + | + | (+) | 23 | .. | .. | .. | .... |
| 11 | .. | .. | .. | .... | 24 | + | | | .... |
| 12 | .. | .. | .. | .... | 25 | .. | + | .. | .... |
| 13 | .. | + | + | .... | 26 | .. | .. | .. | .... |
| | 4/13 | 5/12 | 5/12 | (5/13) | 27 | .. | .. | .. | .... |
| | | | | | | 2/14 | 1/13 | 3/13 | (2/14) |

TABLE 2.—*Number of Patients Who Improved in Two or More Areas in Experimental and Control Groups*

| | Experimental (Drug) | Control (Nondrug) |
|---|---|---|
| Improved | 5 | 0 |
| No change | 8 | 14 |

$P = 0.03$.

TABLE 3.—*Number of Incidents of Improvement in the Experimental and Control Groups*

| | Experimental (Drug) | Control (Nondrug) |
|---|---|---|
| Improved | 14 | 6 |
| No change | 21 | 32 |

$\chi^2$ 5.36 >0.02 level.

An additional significant finding was that there were more incidents of change occurring in the experimental group than in the control group. With the $\chi^2$ test of the total "incidents of change" in C. T., O. T., and H. A. S. (ward), the experimental group differed from the control group at a 0.02 level of significance (Table 3). No significant correlations occurred among the three scales; hence the $\chi^2$ test was used here.

Improvement for the most part was gradual, significant improvement on the rating scales occurring by the second month. One patient appeared to have obtained results only after four to five months of therapy.

### GENERAL IMPRESSIONS

In terms of informally observed improvement, the patients in the experimental group could not be selected from those in the control group by anyone's guessing and identification of these groups. The ward was nonetheless noted to be "quieter" and the patients more "tractable." The nurse reported: "Prior to the institution of reserpine, patients seemed restless . . . there were frequent altercations . . . in general a rather tense, tight atmosphere. After . . . six to eight weeks the ward seemed . . . quieter . . . fewer altercations. . . . Patients seemed more relaxed . . . more aware of each other . . . began asking for more to do."

The testing devices measured such areas as Cooperation, Contact Span, Participation, Interest, Concentration, Alertness, and Accessibility. Consistently improved ratings in those patients who were favorably influenced by the drug were seen only on those items which measured Accessibility and Contact Span.†

An independent study, involving a more exact method of analyzing the changes which occurred as a result of the drug, is currently under analysis. A variation of a method reported by Osgood and Suci [3] was applied to the patient population. Two main results were obtained: (1) A factor analysis of 20 rationally derived scales, on which all the patients had been rated, revealed four independent factors; (2) a combination of pattern and cluster analysis showed that at least five distinct subgroups in this particular patient population were extracted, as defined by the different scores on the four factors. The first tentative results indicated that those patients who "improved" under the drug showed the greatest change on the factor preliminarily labeled "capacity." That is, those who improved moved in the direction of a higher capacity rating. Moreover, those patients with a high initial capacity rating seemed to be the least affected by the drug. This analysis is not yet complete and will be reported at a later time.‡ It would appear, however, that capacity encompasses both the accessibility and the contact span areas of the other rating scales.

### COMMENT

It would appear that the administration of reserpine to chronic schizophrenics alters their behavior, as judged from the testing devices employed. That reserpine was the only consistent major variable in the study would strengthen this conclusion and make observed changes attributable to the drug alone. Especially is this likely to be true if, before any patient is accepted as changing,

† A later cluster analysis revealed that the items in these two rationally labeled areas were actually highly interrelated.

‡ McCullough, P.: Unpublished data.

he must change in at least two different areas. If he changes in only one area, one cannot eliminate the possibility that he had changed as a result of the incidents specific to that one area. If he changed in two or more areas, it was felt that a definite over-all change had probably occurred in the patient, independent of what may have happened in one specific area.

It should be emphasized that reported changes are major ones and do not have to do with subtle changes or their interpretation, as in an interview-type study. Since, at the conclusion of the experiment, no one was able to assess better than by chance who was given the drug, the tidiness of the double-blind design in drug research was preserved. The importance of the double-blind structure was additionally illustrated by what happened to the ratings of patients once their identity became known. Thirty days after the end of the study proper, patient identity having been divulged to the raters, 100% of the experimental group was rated as significantly improved on one of the scales.

That the change induced was gradual, and in no instance (save one) dramatic, was illustrated by the fact that the identity of the drug group remained unknown. Yet the over-all changes in those "improved" patients were real and significant. From the point of view of the ward personnel, definite over-all quieting was noted, and, on the rating scales, there was seemingly consistent improvement in the areas of Contact Span and Accessibility.

This study is in agreement with a growing number of other studies and supports the conclusion that reserpine is a valuable adjunct in psychiatric therapy for some chronically hospitalized schizophrenics. However, the results appear to be somewhat more conservative than those reported in less carefully controlled studies, although there has been little opportunity to compare these results with those for studies using similar groups and experimental designs. It is hoped that as more drugs become available for psychiatric use, experimental designs such as that used in this study will be used early in their evaluation.

## SUMMARY AND CONCLUSIONS

The double-blind design was successfully employed in the evaluation of the effect of reserpine on the behavior of lengthily hospitalized chronic schizophrenics.

Reserpine in a dose of 3 mg.§ appears to have a salutary effect on the behavior of some of this population when evaluated by the testing devices described.

Seeming improvement was noted primarily in the areas of Accessibility and Contact Span.

Major toxicity did not occur.

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§ In five patients who did not respond to the initial dose, the drug was given in the amount of 8 mg. At the end of 31 dosage days no improvement was noted and one patient exhibited Parkinsonism.

# Effects of Mescaline, LSD-25, and Adrenochrome on Depth Electrograms in Man

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In a recent report concerning the reversibility by chlorpromazine of psychoses induced by means of mescaline and *d*-lysergic acid diethylamide (LSD-25), careful attention was given to the clinical and electroencephalographic changes.[1] Although the clinical changes of this reversal effect were immediate and striking, the conventional electroencephalographic changes were minimal, and it was difficult to assess them. It was noted in another recent study that mescaline and LSD-25 failed to activate temporal-lobe epilepsy either clinically or electroencephalographically.[2]

Because of these factors, it was hoped that depth electrographic studies might be fruitful in elucidating the effects of these drugs. It was hoped also that study by means of depth electrography of the effects of adrenochrome might elucidate its reported actions of inducing a psychosis without insight in volunteers [3] and increasing the paroxysmal discharges in the electroencephalograms of epileptics.[4] Scalp electroencephalography and depth electrography were undertaken as specific aids to diagnosis and as preliminary measures to definitive surgical treatment in each patient in our study.

## METHOD

After the administration of mescaline and LSD-25, two patients who had intractable epilepsy and psychosis and three who had chronic schizophrenia were studied by means of the techniques of depth electrography developed and defined in this laboratory.* One of the epileptic and two of the schizophrenic patients also received adrenochrome. Each patient had extensive control studies, lasting as long as two weeks per patient, previous to the time of administration of the drug. Further control observations were repeated every day of the study. Electrocardiograms were recorded simultaneously with depth electrograms in two patients.

The dose of mescaline varied between 400 mg. and 1 gm., whereas that of LSD-25 ranged from 50γ to 150γ. The dose of adrenochrome† varied between 50 and 75 mg. The mescaline and LSD-25 were administered orally; the adrenochrome was given intravenously as a freshly prepared solution in 10 cc. of sterile water. At the presumed height of the reactions to mescaline and LSD-25, each patient received an intravenous injection of 50 mg. of chlorpromazine dissolved in 10 cc. of sterile water. The mescaline, LSD-25, and adrenochrome were administered during the fasting state in all instances.

## CLINICAL RESULTS

The clinical results are summarized in the accompanying Table. This report is based on 18 observations, 6 with mescaline, 6 with LSD-25, and 6 with adrenochrome. With the doses of drugs used, the clinical effects were moderate when compared with the responses of a series of volunteers [1] and a group of epileptics [2] without psychosis, who received substantially smaller doses than were used in this study.

Mescaline produced autonomic changes consisting of slight pupillary dilatation and facial flushing. In the psychic sphere, three patients who were negativistic in the control

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From the Rochester State Hospital.

* References 5 and 6.

† A. Hoffer, M.D., Ph.D., director of psychiatric research, University Hospital, Saskatoon, Sask., Canada, supplied pure adrenochrome.

*Clinical Response and Changes in Depth Electrograms Produced by Mescaline, LSD-25, and Adrenochrome*

| Patient | Diagnosis | Drug and Dose | Clinical Response | Changes in Depth Electrogram | Reversal Effect of Chlorpromazine, 50 mg. | |
|---|---|---|---|---|---|---|
| | | | | | Clinical Effect | Effect on Electrogram |
| 1 | Chronic paranoid schizophrenia; scalp EEG essentially normal | Mescaline, 1 gm. | Inappropriately silly, loosening of associations, flushed facies, dilated pupils | Diminution in voltage from temporal depths, with increased occurrence of paroxysmal discharges of 2 to 7 cps | Restored to control status | Paroxysmal discharges persisted but were interspersed with slower frequencies of medium voltage and 2 to 3 cps |
| | | LSD-25, 100γ | Persistent silly smile | Synchronous paroxysmal discharges of 2 to 7 cps | Restored to control status; slight drowsiness | Same as above |
| | | Adrenochrome 50 mg. | Body-image disturbances: "My arm wiggles—ha, ha . . . see it happen." Perceived "red" on photic stimulation | Moderate increase in bitemporal paroxysmal discharge of 2 to 7 cps; increased persistence and amplitude of focal temporal sharp-wave discharge from depths | ..... | ..... |
| | | 60 mg. | Essentially the same as with 50 mg. | Same electrographic changes | ..... | ..... |
| | | 75 mg. | Essentially the same as with 50 mg. | Same electrographic changes | ..... | ..... |
| 2 | Chronic catatonic schizophrenia; scalp EEG showed Grade 1 bitemporal dysrhythmia | Mescaline, 1 gm. | Minimal effect; flushed facies | Increased paroxysmal activity | Relaxation | Restoration of occipital depth alpha-like activity |
| | | LSD-25, 100γ | Grinning, laughing; looked in mirror and said, "It looks different"; bit nails; chewing movements, perspiration, flushed facies | Same electrographic changes | Facies restored to control pattern; restless, moaned without apparent reason | Rhythmic fast build-up initially |
| | | Adrenochrome 50 mg. | Pleasant smile on face; waxy flexibility; colors on photic stimulation | Moderate increase in paroxysmal activity | ..... | ..... |
| | | 60 mg. | Very relaxed; waxy flexibility; colors on photic stimulation | Same electrographic changes | ..... | ..... |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Chronic catatonic schizophrenia; scalp EEG essentially normal | Mescaline, 400 mg. | Mescaline facies; relatively communicative; posturizing; appears to have hallucinations | Minimal | ..... | ..... |
| | | LSD-25, 50γ | Grinning, laughing, talking to self, more communicative | Minimal | ..... | ..... |
| 4 * | Psychosis with convulsive disorder and epileptic deterioration; scalp EEG showed dysrhythmia Grade 3, right sylvian sharp wave | Mescaline, 400 mg. | Talkative, buoyant; "I see bugs —they say I'm not nice"; mescaline facies, pupillary dilatation | Quieting effect on spike activity and background; occipital bursts with eyes closed during music; synchronous waxing and waning of alpha-like activity with music | Restored to control status, other than slight drowsiness | Record resembled control tracing |
| | | LSD-25, 50γ | Talkative; saw "colors of all different shapes" on photic stimulation | Changes similar to mescaline changes but not so clear | Same effect as with mescaline | Same effect as with mescaline |
| 5 † | Psychosis with convulsive disorder and epileptic deterioration; scalp EEG showed dysrhythmia Grade 3, right sylvian sharp wave | Mescaline, 1 gm. | Voluble word salad; euphoric; continuous hallucinations; suggestion of catatonia; posturizing; smacking of lips; perspiration; dilated pupils; mescaline facies | Diminution of epileptic spike discharges with generalized decrease in voltage; appearance of new spike focus in temporal depths, which fired continuously with double spikes 3 times per second; focus stopped firing a few times for 6 to 8 sec. before chlorpromazine was used; continuous focal high-voltage activity from ventromedial region of frontal lobe during pronounced hallucinations | Restored to control state; sullen, negativistic, uncooperative | Record resembled control state; complete abolition of double spikes elicited by mescaline; record changed three times after injection of chlorpromazine |
| | | LSD-25 100γ | Talkative, laughing, euphoric; word salad; flushed facies | As above | As above | ..... |
| | | 150γ | Restless, difficult to get in contact with, laughing, euphoric, talkative; word salad | As above | As above | ..... |
| | | Adrenochrome 50 mg. | Very relaxed; drowsy yet easily aroused; in better contact | High-voltage waves 2 to 3 cps associated with drowsiness | ..... | ..... |

* Patient had excision of local cerebral scar with pronounced gliosis deep in right temporal lobe, as determined by depth studies.

† Clinical effects and changes in depth electrogram produced by mescaline could not be nullified by convulsions produced by pentylenetetrazol (Metrazol).

states became more communicative and euphoric. Their stream of thought showed the same complexes that were noted in the control period; however, further loosening of the associations was noted. In general, these reactions reached their height two to four hours after the drug was given and then subsided immediately after the intravenous injection of chlorpromazine.

patients were in better contact and mood after these studies.

It was difficult to evaluate the effects of adrenochrome on the psyche. The epileptic (Patient 5 in the Table) appeared to be relaxed and became drowsy. One schizophrenic (Patient 1) appeared to show loosening of associations and increase in disturbances of body image; for instance, he

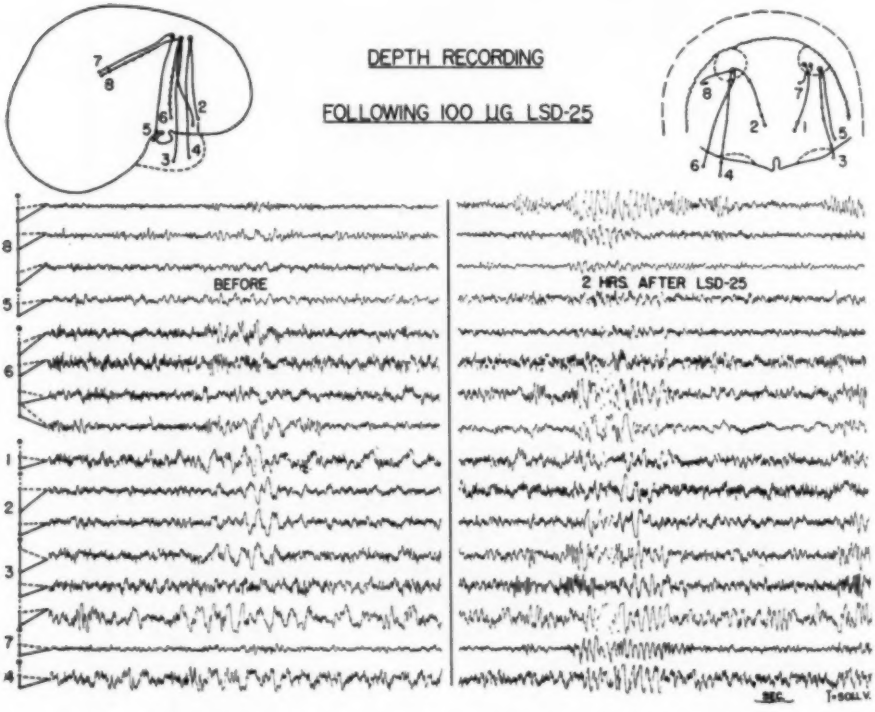


Fig. 1.—Generalized paroxysmal burst in a schizophrenic patient. Before medication, the paroxysms occurred infrequently; after administration of 100γ of LSD-25, they occurred every 10 to 20 seconds.

The clinical effects of LSD-25 closely resembled those of mescaline, although the mescaline reactions in this study appeared to be more intense and were associated with a typical facies. However, inappropriate laughing and giggling were noted more commonly after use of LSD-25 than after administration of mescaline. In several instances when the patients were returned to the ward after receiving mescaline and LSD-25, the nurses volunteered the observation that the

raised his hand, gazed at it, and said, "My arm wiggles and waves—ha, ha!" The other schizophrenic who received adrenochrome (Patient 2) experienced catalepsy on two occasions, which persisted for more than 30 minutes. At these times, his upper extremities were held in unnatural positions that volunteers who served as controls could not maintain for long. This was not his usual reaction, and a similar state did not develop with either mescaline or LSD-25.

EFFECTS ON DEPTH ELECTROGRAM

The effects on the depth electrogram also are summarized in the Table. A generalized diminution in voltage of the depth rhythms from the two epileptic patients was noted approximately 30 minutes to 2 hours after the oral administration of mescaline and LSD-25. The three schizophrenic patients responded to these drugs with an increased paroxysmal activity (Fig. 1). There was no apparent correlation between the dose of these drugs and the effects produced clinically or on the depth electrograms.

In the two epileptic patients, foci of spike waves that existed in the control period on occasions tended to decrease greatly after the administration of mescaline and LSD-25. The tracings from Patient 5, an epileptic, showed a new activity in the form of spike waves recorded from the depths of the temporal lobe. They were double spikes that were present continuously for several hours at the rate of 3 per second (Fig. 2). The pulse rate during the entire test was at no time more than 120 beats per minute. At the time of the persistent double spikes, the patient, as judged by the facial expression, behavioral reactions, and verbal admission, was continuously disturbed, presumably with pronounced hallucinations. Continuous focal high-voltage activity at this stage was recorded from the ventromedial region of the frontal lobe (Fig. 2, bottom tracing). The temporal double-spike discharge very infrequently ceased during the test for more than six to eight seconds. Patient 4, the other epileptic, at the height of the reaction to mescaline and while having visual hallucinations, showed polyphasic spike discharges from the depths of the occipital region (Fig. 3, upper strip). These were more prominent in the presence of synesthetic visions induced by mescaline. In some respects, these discharges resembled lambda

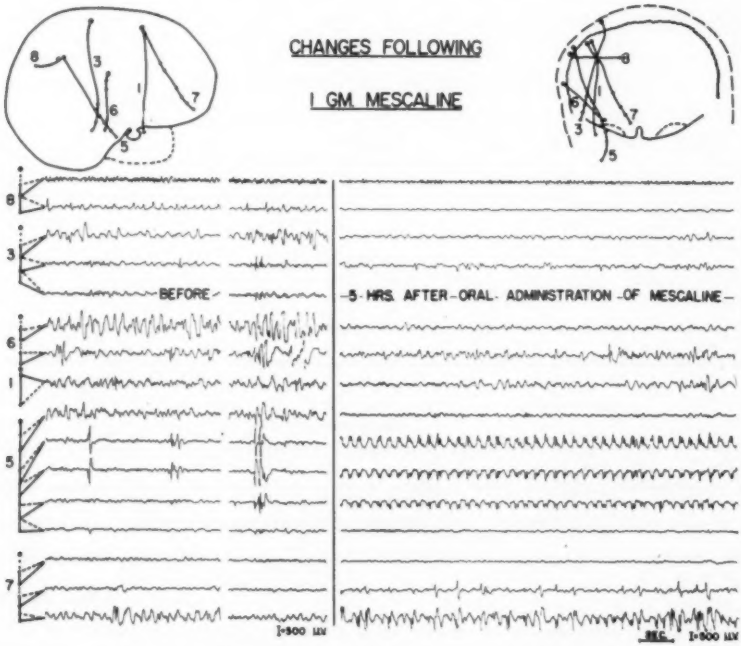


Fig. 2.—Changes in the depth electrogram after administration of 1 gm. of mescaline to an epileptic patient. Note diminution in voltage of the spike discharges and appearance of a persistent new double-spike focus.

waves, as seen from electroencephalograms recorded from the scalp. However, in the depth records they consisted of a burst of polyphasic spikes. Lambda waves in depth are monophasic or biphasic,[6] as seen in the top strip of Figure 3.

Patient 4, who was especially cooperative while under the influence of mescaline, also had waxing and waning of the alpha-like spindles from the depths of the occipital region that corresponded with the rhythms of music (Fig. 3, middle and lower strips). For instance, she had one pattern with a control patterns present before the use of mescaline and LSD-25. However, the reversal process in Patient 5 was characterized by complex changes, as illustrated in Figures 4 and 5. In one instance (Patient 5), the record changed spontaneously before the use of chlorpromazine, with the appearance of fast activity; it then went directly from this state to the premescaline state, with less pronounced complex changes (Figs. 4 and 5). On this occasion, the tracing resembled the premescaline recording for five minutes before it reverted to the mescaline type of

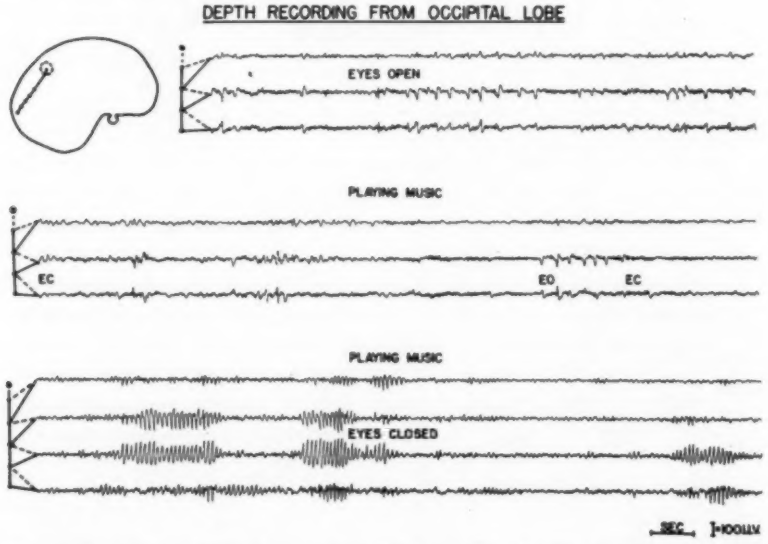


Fig. 3.—Depth electrograms in another epileptic patient. Control lambda waves with the patient looking at a picture are recorded in the top strip. The middle strip illustrates the polyphasic spike discharges associated with synesthetic visions induced by administration of mescaline. The lower strip shows synchronous waxing and waning of alpha-like discharges associated with music during the mescaline effect. All three strips were recorded from the same electrodes.

relaxing harmonica waltz, another with some swing music, and still a third pattern with a mournful hillbilly tune. This synchronous alpha-like activity occurred at the height of her mescaline-induced state, whereas it never appeared without music or in the control period with music.

Within a few minutes after the intravenous administration of 50 mg. of chlorpromazine, the electrographic recordings reverted to the recording. As seen in Figures 4 and 5, the double spikes from the depths of the temporal lobe disappeared and the epileptic foci resumed their control appearance. In Patient 4, musically driven occipital bursts associated with visual hallucinations under the influence of mescaline were not present after use of chlorpromazine. Other than occasional slight drowsiness, which was accompanied infrequently by slower frequencies, the pa-

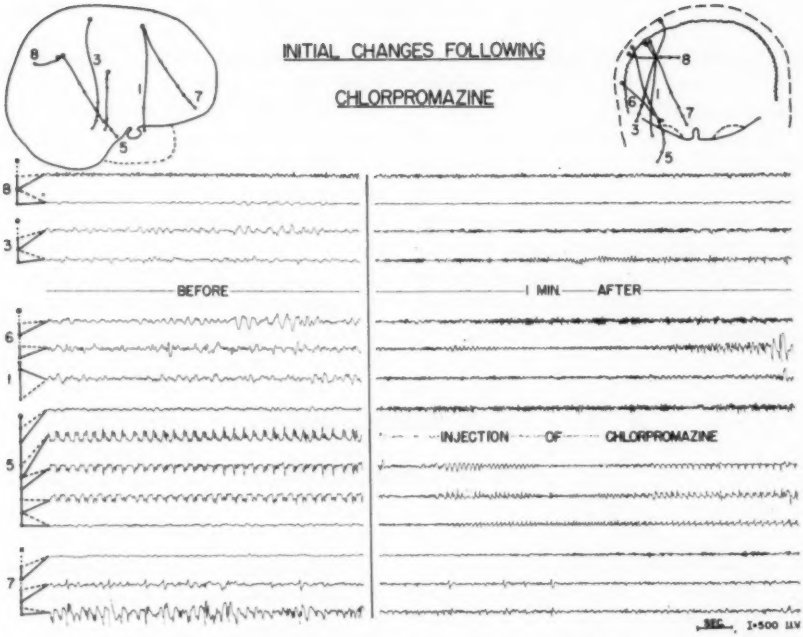


Fig. 4.—Effect of chlorpromazine on the electrogram of an epileptic patient. Note the appearance of fast activity one minute after the intravenous injection of 50 mg. of chlorpromazine.

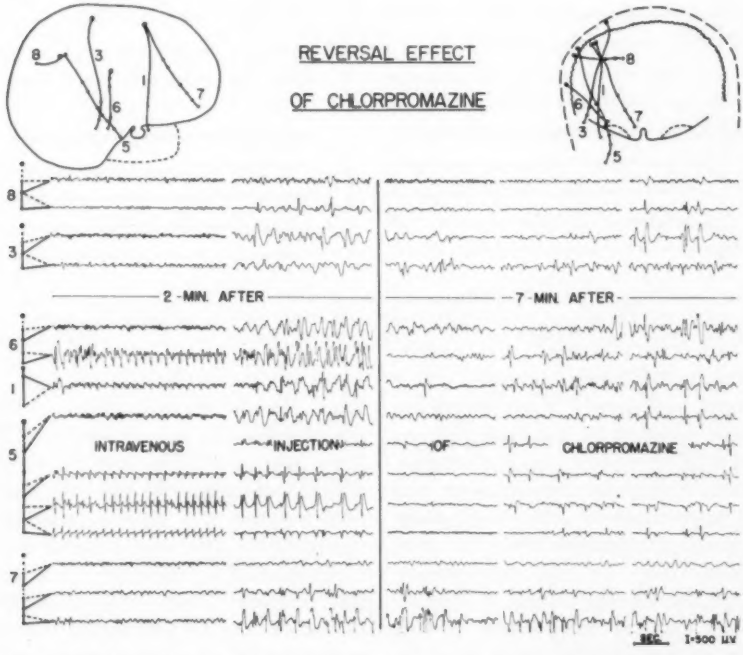


Fig. 5.—Further effects of chlorpromazine in same patient whose electrogram is seen in Figure 4. Note the complex changes before the record reverted to the premescaline stage.

tients clinically resembled their control condition. They were always readily alertable and had clear sensoriums.

An increase in the existing paroxysmal activity was noted in the two schizophrenics (Patients 1 and 2) who received varying doses of adrenochrome at different times. Patient 1 showed a focal sharp wave in activity recorded from the temporal region at rare intervals during the control study. This had some resemblance to similar activity de-

not accompanied by any clinical changes other than relaxation.

The electrocardiograms showed no gross changes, as recorded in two schizophrenic patients, between the control states and the states induced by the use of mescaline, LSD-25, and adrenochrome.

## COMMENT

It would appear that administration of mescaline, LSD-25, and adrenochrome can

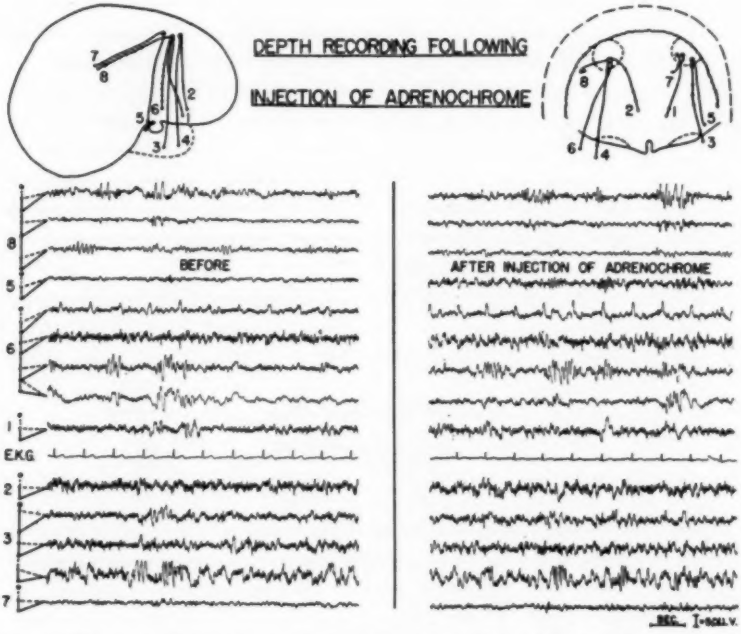


Fig. 6.—Effects of adrenochrome on the electrogram of a schizophrenic. Note the focal sharp wave seen at rare intervals in the control recording and its persistent appearance with higher voltage after administration of 50 mg. of adrenochrome.

scribed in an earlier paper.[7] However, in the control period of Patient 1, it was impossible to determine whether he had hallucinations at the time of this focal sharp discharge. After injection of adrenochrome, there was persistent appearance of this focal sharp wave of maximal amplitude from the temporal region (Fig. 6). In the epileptic (Patient 5), the administration of adrenochrome was followed immediately by the appearance of high-voltage waves of 2 or 3 cps, associated with drowsiness. This was

cause striking changes in the depth electrogram. Because the observations in this study were confined to two patients who had epilepsy with psychosis and three who had chronic schizophrenia, these definite limitations preclude any general statements with regard to the effects of these drugs. However, it should be noted that the activation of the temporal depths by mescaline and LSD-25 in one patient appeared to coincide with a period of active auditory and visual hallucinations. It should be noted also that

the double spikes produced by mescaline and LSD-25 appeared in the proximity of a region from which a similar discharge was found in a patient during spontaneous hallucinations without any previous administration of drugs.[7] A common mechanism might be activated that accounts for the acute psychotic episode. The immediate reversing effects of intravenous administration of chlorpromazine on the clinical and electrographic states induced by means of mescaline and LSD-25 are suggestive of a possible mode of action centered in this region.

The psychic effects and those produced on the depth electrograms in the two schizophrenics by use of adrenochrome are similar to those reported by Szatmari and associates,[4] who described an increase in bilateral paroxysmal abnormalities in electroencephalograms recorded from the scalps of epileptics. The observation that adrenochrome failed to induce clinical and electrographic changes similar to those produced by mescaline and LSD-25 in our epileptic (Patient 5) suggests that adrenochrome or one of its degradation products is not involved in the mediating action of mescaline and LSD-25, as hypothesized previously.

## SUMMARY

During depth-electrographic studies, mescaline and *d*-lysergic acid diethylamide (LSD-25) have been administered to five patients; two of them had psychosis with convulsive disorders, and three had chronic schizophrenia. The most striking observation in the epileptics was that mescaline and LSD-25 had a pronounced quieting effect on the spike and sharp-wave foci in depth recordings. An increase in paroxysmal activity characterized by waves of 2 to 5 cps occurred in the patients who had chronic schizophrenia. Mescaline and LSD-25 elicited the appearance of a double-spike focus deep in the temporal lobe in one epileptic patient.

The clinical effects and those on the depth electrogram produced by mescaline and LSD-25 were reversed by the injection of chlorpromazine.

Intravenous administration of adrenochrome to two patients who had chronic schizophrenia produced an increase in paroxysmal activity manifested by waves of 2 to 5 cps. An increase in paroxysmal activity of 2 to 3 cps occurred in a patient who had a psychosis with a convulsive disorder.

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# Model Psychoses Induced by LSD-25 in Normals

## I. Psychophysiological Investigations, with Special Reference to the Mechanism of the Paranoid Reaction

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### INTRODUCTION

Experimental psychosis has a long history. It might have started with the administration of Cannabis indica boiling in wine to the ancient Hun warriors, resulting in mental obfuscation, as they were prepared for surgery because of wounds sustained in battle. Scientific experimental psychiatry began toward the end of the last century, in the Kraepelinian era—when the organic theory of psychoses was in its fullest vogue. Beringer's experiments with mescaline [1] marked a milestone in research in that many of the symptoms induced were highly similar to those encountered in schizophrenia and the drug seemed to have had a selective affinity for the brain. The discovery of LSD-25* by Stoll and Hoffmann [2] was an even more exciting event, because the drug worked similarly in infinitesimal-trace amounts. Stoll [3] (1947) suggested the pharmacological designation *Phantastium* for this substance, and he classified the resultant model psychosis as that of the acute exogenous reaction type. Such psychoses are said to exaggerate and caricature the underlying personality of the subject.

Some toxic-organic psychoses, however, have some symptoms all their own. Thus, regardless of the personality structure, the "perception" of moving small animals, in abundance and of vivid coloring, is the stereotype feature of delirium tremens, and confabulations filling in the memory gaps is characteristic of Korsakoff syndrome as part of a cerebral metabolic deficiency state associated with specific involvements in the brain. Those who aver that all psychoses have a biological basis were for a long time on the lookout for a broader foundation, and the drug-induced models were quickly incorporated in this search. No biological theory of psychosis, however, can be held valid if it fails to identify the anatomical area involved or the physiological and biochemical mechanism responsible for dysfunction. The discussion that follows clearly demonstates how very far psychiatry is from the biological theory; it will attempt to summarize the ever-increasing pieces of a theoretical mosaic which represent contributions from many related disciplines, such as psychiatry, psychology, clinical neurology, neurophysiology, neuropathology, biochemistry, neuropharmacology, neurosurgery, and biophysics. Finally, a few working theories will be submitted for critical analysis.

There are excellent surveys available in the literature on the effects of LSD-25 on

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* *d*-Lysergic acid diethylamide is a semisynthetic derivative obtained by condensation of *d*-lysergic acid, an extract of ergot, with diethylamine, a secondary amine. LSD-25 thus belongs to the ergonovine group. The drug was supplied to us by Prof. E. Rothlin, of the Sandoz Pharmaceutical Co., Basel, Switzerland, and its West Coast representative, Mr. Harry Althouse, San Francisco.

normal,† psychotic,‡ and neurotic § humans and on animals. It might be important to point out the differences among the authors in their approach to the study of the effects of this drug. Since the original publication of Stoll (1947) many authors have more or less completely confirmed his findings, employing mostly subjects trained in the biological sciences, and through self-experimentation. Some of the salient features of this intoxication become quickly obvious to even the untrained observer, who, while maintaining a state of self-scrutiny and detachment, is quick to point out particularly his perceptual anomalies. The majority of changes, however, strangely enough, first become noticeable only upon questioning, and it is then that the wide range of variation from one experimental sample to another becomes clear. Self-scrutiny varies in degree from one person to another, and the meaning of the test is conceivably different to each one; even so, the richness of the description and the very difficulty in trying to report often vague changes of the mind itself are distinguishing features of the LSD effect.

It would appear, therefore, of value to relate the personality structure of the subject to his LSD state. One suspects that differences in reaction to the drug might depend partly on the scientific sophistication of the subject, which could account for some of the discrepancies found in the literature as one tries to reconcile the various descriptions. Abramson [23] even called attention to the element of suggestibility of the subject and to the suggestive influence of the investigator, for which there appeared to be a good deal of evidence in the present series.

## SELECTION OF MATERIAL

LSD-25 was administered to 25 presumably normal subjects, none of whom, to our best knowledge and in their own admission, suffered from any psychiatric disturbance. The age level varied from 20 to 35 years, and by profession they were classified as follows: four students in physiology, three students in psychology, one medical student, one graduate in theology, six actresses in television, one insurance salesman, one physicist, one car salesman, one ski instructor, two housewives, one grammar school teacher, one girl without any occupation, one filling station attendant, and one laboratory attendant. There were 17 men and 8 women.

At the beginning of our experiments, in the summer of 1951, LSD-25 was generally unknown to the public—in fact, even to many in the psychiatric professions. In the selection of our cases, therefore, we did not have the problem of overcoming artificial prejudices; on the other hand, a great deal more explanation was necessary in convincing the subjects to submit to the test than was the case later on, when several reports appeared, not only in medical journals but in magazines and newspapers, about the strange effects of this drug. Selection of the candidates was done with extreme care.

Usually a prospect was approached by one member of the team, who told him that scientific investigation of the effect of certain drugs on the working mechanism of the mind was in progress at our university. We were in need of volunteers who were considered normal. As a result of the ingestion of a tasteless and harmless liquid, they were going to experience something akin to alcoholic intoxication. They would be required to cooperate in describing whatever changes occurred; they would lie comfortably on a cot; they would be fed lunch at a certain time, and transportation would be provided to and from the place where these experiments were to take place. They were reassured that disturbing after-effects were not expected, that in all probability they would be free to do whatever they wished the evening of these experiments, and that self-scrutiny and insight would never be lost at any time.||

Only in two instances were our requests turned down because of fear. Three other candidates tried to get out of the experiments by giving all kinds of excuses, which, while quite plausible, left us to suspect that they were covering up their fears. No attempt was made to insist beyond this point.

As a general rule, most of the subjects were quite satisfied, interested, and even delighted by what went on, and, judging from their eagerness in trying to line up for subsequent control tests, it appeared that they were very intrigued about the outcome of the test. Some of them later asked to read the

† References 3-12.

‡ References 13 and 15-20.

§ References 14 and 21-25.

|| By now, several hundred subjects have been submitted to the LSD test, and from personal communication we know of four instances in which the drug precipitated a psychosis, one with a suicidal tendency. The law of averages will inevitably assert itself as the number of experiments increases, but the correctness of the above reassurance essentially prevails.

verbatim transcription of the experiment in order to satisfy this curiosity, also because exact recollection of the happenings was often obscure. They related occasionally during the experiment that they felt uncomfortable, anxious, or scared, but in retrospect they were quick to point out that they never regretted having undergone this experiment. The feeling was general that most subjects of this series considered their having undergone this test as a sign of valor. Many were eager to recruit other volunteers, and, at times, it was established that they did so out of sadistic-hostile motivation. Whenever such a subject volunteered to bring a friend, he was closely questioned about his relationship with the prospect. That this was justified was demonstrated by the refusal of a good number of the prospects to comply, indicating, at least on the surface, that the motives of the inducer were doubted or else that his qualification for giving reassurance was not found quite satisfactory. This was admitted by those who, upon our own intervention and repetition of the reassurance, finally consented to come. There was one instance in which a husband was eager to convince his wife to volunteer and it was later established that he harbored a great deal of resentment against her.

Six subjects in this series were entertainers on radio and television. They were motivated by an unusual amount of curiosity, and they expressed a wish to read the four-hour-test protocols to one another in a group. They were exhibitionistic in the test, as they were in their own profession. There were more specific motivations to induce others to volunteer. One member of this group contemplated marrying one of our prospects, but he was not able to satisfy his sense of uncertainty about her qualifications. He frankly admitted that he would like to learn something about "what really makes this girl tick."

Whether the senior author of this article was the one who made the first step in trying to recruit volunteers or not, there was never any doubt about his being the leader. The subject's relationship with him during the height of the LSD effect often contained the irrational elements of his relationship to important authority figures, as determined by questioning his friends, relatives, and himself, and by examining the personality tests. In paranoid states the senior author was always the supreme target.

In spite of all the precautions taken to select subjects from the normal population, the control Rorschach test not infrequently brought out latent neurotic, and even schizophrenic, trends which appeared potentially disturbing. It was striking that these were the subjects who were most insistent in urging the author to live up to his promises and to deliver the Rorschach results to them as soon as possible. It would appear to be strongly advisable to be on the lookout for incipient schizophrenia during the process of selection, as the test (in reality a form of stress) could conceivably lead to decompensation.

During the second half of this study, articles appeared in national magazines and in newspapers about experiments with LSD-25 in other institutions. It seemed to us that this preexisting knowledge about LSD-25 had a double effect in our selections. There was an increased amount of curiosity and willingness to experience the bizarre effects of this drug, which were rather sensationally treated in the press, and the prospects required more reassurance about the safety and reliability of these experiments than their earlier colleagues. Fortunately, by that time more than half of our subjects had had their tests, so that we had a certain degree of authority with which to underscore our verbal assurances.

One member of the investigating team was a woman. Only one male subject, who was her acquaintance, showed signs of sexual stimulation toward her at the height of his euphoria. This would confirm the prevailing opinion,[3] debated by few,[20] that sexual drive in the LSD state is, if anything, decreased.

## METHOD

The average amount of LSD-25 (given by mouth in distilled water) varied from 30γ to 100γ; but only two subjects had less than 40γ, and the majority received 1γ per kilogram of body weight. The experiments started at noon, the subject having had nothing to eat since breakfast. Lunch, which uniformly consisted of minced meat, bun, and malted milk, was served approximately three hours after the start. The subject would lie comfortably on a padded cot in a Faraday cage lined with a plastic board and provided with a window and a door, which was closed only when the EEG was recorded. Conventional needle electrodes were inserted in the scalp in the frontal, motor, temporal, and parietal-occipital areas and left in place during the experiment. A Grass III eight-channel apparatus was used, and the electrode combinations were both monopolar and bipolar. Each channel was fed into the input of an Offner differential automatic analyzer, which recorded six individual 10-second epochs per channel, and the frequency distribution from each area of the brain was quantitated in the form of a mean histogram on graded paper. The control EEG was recorded during the 10 minutes following the administration of LSD-25, when no effects could be expected, and none were observed or reported by the subject. Only during the few minutes of EEG recording was the subject left alone, though he was still watched through the window.

The first sign of LSD effect consisted of dilatation of the pupil, which occurred from 20 to 30

minutes after ingestion of the drug. Rarely were the subjects conscious of any particular change by that time. Subsequent recordings were made just prior to the administration of the Rorschach tests, one hour after the beginning, and also at two, and even in some instances three, hours after administration of the drug, when the effect reached maximal proportions. In almost every instance, at the end of the experiment (four hours) the EEG was back where it was in the beginning. Rarely, departure from this rigid schedule was made to record the EEG at such times as the subject reported particularly interesting or intensive delusional or hallucinatory phenomena. The effect of single-light-flash stimulation was studied with each sample. This was done in a darkened room with the subject's eyes closed. In some instances air blast through a rubber hose applied to the skin, usually on the leg, operated by an electronic valve, was also used both before and during the LSD effect.

At the height of the intoxication, which usually fell between the second and the third hour, in rapid succession serial seven-digit and test-word retention and recall tests were given, followed by tapping-rate determination of both hands. Tendon reflexes and coordination were tested according to a routine neurological survey of the central nervous system, in turn followed by a two-line writing test and a drawing test that was supposed to gauge ability to judge distance and parallelism and to draw circles. Remote and recent memory was tested in the conventional manner before and during the LSD effect. All these tests were finally repeated several weeks later, when the control Rorschach test was administered.

Throughout the four hours of testing, as nearly complete silence prevailed in the room as was possible. Movements of the members of the team in the neighboring rooms were reduced to an unavoidable minimum. The few standard auditory stimuli consisted of the monotonous drone of the paper drive of the EEG machine, the periodic clicking of the automatic analyzer, and the chimes of a nearby church at 15-minute intervals. All of these played a role and were commented upon during the experiments. In the hypomanic phase, the features of the examiner (at the time only one was in the cage), his clothes, pencil, and paper, were all included in the flighty, distracted verbalization of the subject. A Magnascriber wire recorder was set up in the neighboring room, with remote control and microphone attachments inside the cage. Not only the individual productions but also everything pertinent to the experiment was dictated into the sound track, and all the statements were time-marked. Whenever EEG recording was done simultaneously with the subject's description of his delusions and hallucinations, time markers were made on the EEG paper. The transcription was a phonetic one; not only were the patient's exact productions reproduced faithfully, but even his moanings and grunts were transcribed with as great a fidelity as was possible. Silences and hesitancy were marked on the transcription with dots.

It was felt that a compromise had to be reached between limiting the stimuli to the unavoidable minimum, keeping the environment as constant as possible, even though our set-up might have suffered from the impossibility of testing gait, station, and balance, and the possible distracting effects of objects and personnel that were outside the subject's visual field, under the conditions stated above. After the volunteers were taken home, they were invited to describe on paper whatever possible late effects the drug may have had upon them, but only in two instances were prolonged after-effects of significance reported. These experiments were done on Saturday, and no one was warned to change his usual plan for weekend activity. The subjects were guarded, however, from indulging in excessive amounts of alcohol, which was arbitrarily limited by us to two drinks. Even so, the majority of those who drank alcohol reported that their tolerance on that night was low, and it was exceedingly easy for them to get intoxicated. However, the form that this intoxication took was uniformly the same, namely, irresistible sleepiness. No one suffered major gastrointestinal disturbances either during or for the rest of the day after the experiments. One subject was a linotype setter for a local newspaper, who went to work two hours after the end of the experiment. He reported having heard several complaints of the many mistakes in spelling that he made that night. On the other hand, another subject, a student in physiology, who was preparing for an examination, was able to spend the evening and the following day in hard preparation without experiencing any difficulty in his efforts.

In all but the two first cases, the control Rorschach test was administered (no less than five weeks) after the LSD test. Owing to defects in retention and recall produced by LSD, the control test was less contaminated by the recollection of the drug Rorschach test than was true the other way around.

## RESULTS

### A. Autonomic Changes

Dilatation of the pupil was present in each case; in fact, it was the first noticeable sign. It occurred on an average within 30 minutes, and in one hour the pupil reached its maximum diameter. Three and a half hours following administration it began to decrease in size, though even after four hours, when most of the experiments were concluded, the pupil was still not back to its original size.

In four cases dilatation was noticed as late as seven hours after the start. In one instance, one pupil was dilated more than the other in a woman who used to complain of migraine headache and in whom a difference in the pupils during the headache had been noted previously.

Increased perspiration, particularly of the hands, was noted in three instances to a great excess and in six instances to a slight extent.

A feeling of general warmth occurred in one instance; it was of a definite, sharp onset and disappeared just as quickly, persisting for three minutes. In one instance a subject complained of a typical bolus hystericus. Five cases reported a mild degree of nausea.

The intensity of the autonomic changes did not seem to depend on the dose, which was maximally 1γ per kilogram.

B. Perceptual Anomalies

1. *Visual Sensations.*—Visual manifestations were most prevalent, as compared with other sensory changes (18 cases). There is no explanation for the comparative sensitivity of the visual system to LSD, though it never reached the predominance of eidetic phenomena described in mescaline-induced states. There was certainly no correlation with the high alpha index on the EEG, which some authors have related to great visual imagery in thinking.

Commonest were illusions, particularly noticeable with the eyes closed, of which examples are given.

Bright yellow coils that seem to jiggle like the lines of a poorly functioning television screen. These later on changed into a multicolored, painted turtle, with the colors flowing into one another rapidly.

Black slivers, in the shape of a diamond, the angles of which disappeared when someone clapped his hand close to the subject's ear.

In another case, light manual pressure over one eye caused a black-and-blue-colored, giant bug to appear in that eye, which quickly changed into multicolored flutes, then just as quickly into a spiral staircase, then into modern windows looking out on a pool and a house with the San Francisco Bay Bridge, with the rising sun behind it. This subject emphasized the extraordinary precision and vividness particularly of the last picture and insisted that one should let him enjoy this scenery a little while longer.

Another subject first saw Gothic windows with his eyes closed. Later on, however, searchlights appeared in the bottom of his visual field, with the beams directed upward in a vertical direction, making everything around them extremely dark.

Flickering flash bulbs spread out in a horizontal plane, oscillating and then quickly changing into multicolored ribbons, interrupted by spikes spaced at regular intervals.

Primitive masks of various colors with wings on them, changing into angular, crawling, filmy, feathery croppings, like a forest. In this instance, the change from the mask to the forest occurred upon clapping of the hands. At times, the images seen with eyes closed were very simple, like, for instance, gray-colored, muddy-looking curves, which, upon clapping of the hands, became suddenly elongated and then stayed that way.

One interesting feature of this set of symptoms was the fact that Gothic or cathedral windows, which some of the subjects were capable of reproducing with pencil and paper, were reported by seven subjects. Mayer-Gross also noted that under mescaline he had imageries of cathedrals.

With eyes open, one subject could see a crimson-colored glow around the edges of all kinds of objects placed before his eyes, upon which the light had fallen.

Visual hallucinations with the eyes open were reported by three subjects.

One subject, with eyes open, saw Mexican peons with sombreros, dancing or hopping around on donkeys.

Another subject saw, in a completely darkened room, light moving very slowly and deliberately from left to right, hitting only the subject's eyes in a cyclic fashion.

A third subject saw geometrical figures, half-purple and half-black in color, coalescing into a goldfish, and the goldfish then would dance on the wall with the hindfins moving rhythmically.

Anomalies of visual perspective, such as micropsia, metamorphopsia, and heteromegalometamorphopsia, were from time to time (usually for short periods) reported by 10 subjects. Some of these visual sensations were quite complex. For instance, one subject saw the cover of *Time* magazine, with eyes open, upon looking on the wall, with the faintly discernible photograph dilating and contracting in size at first, and later on coming out of the red frame and retracting into it in a rhythmic fashion. This he noted to be

synchronous with his breathing. By holding his breath, for instance, he was able to hold the image quite close to his eyes.

The quick change-over from one image to another is illustrated by a subject who, at first with eyes closed, saw a stained Gothic window, the green colors of which began to peel off, turning quickly into autumn leaves, and by the time these autumn leaves had fallen to the ground they quickly changed over into peacock feathers, covering the ground in a random fashion.

It was interesting that the emotional reaction described by the subjects to these various strange occurrences varied from one order of sensation to another. Many subjects, up to the time when they were asked to close their eyes and to describe what they had seen, if anything, emphasized that they felt exactly as if they had taken two martinis and they were in no way in a position to detect anything novel about their state of intoxication. The moment they closed their eyes, however, and the above-described illusions appeared, they were quick to point out that this experience was a different one. Their reactions to the extraordinary variety of the illusions and images, whether they were looking upon them with eyes open or closed, was frequently one of exhilaration, and delight in some instances, and they were quite irritated when they felt that the observers would not allow them to continue to be absorbed and insisted on precise description. They would raise their hands and wave the observers away or, in some instances, very annoyedly ask them to be quiet for a minute, complaining that the kaleidoscopic images followed one another with such extraordinary variety that they were not able to give a proper verbal account.

The situation, however, became at times dramatically reversed when the subjects began to report shrinking or dilatation of images, or when walls were "breathing" in and out, or when various multicolored halos appeared around the lighted edges of certain objects placed in front of them. The prevalent emotional reaction now was one of apprehension. They admitted even a reluctance to describe them, and very frequently they had to be coaxed. It seems that dissolution of the familiar landmarks or spatial orientation was upsetting, and sometimes threatening to their reality control.

2. *Auditory Sensations.*—Nine subjects reported transient hyperacusis, and two noted sound reverberations. On the other hand, auditory stimuli frequently had a profound effect on other sensory experiences.

3. *Gustatory Sensations.* — In one case, nausea was associated with a tobacco-like taste in the mouth in a subject who had never smoked, but the clarity suggested an actual hallucination. This appeared after two hours and lasted two minutes; then in another half-hour it returned and lasted for one minute.

In another case, nausea and a metallic taste occurred each time that the subject had visual reverberations.

4. *Vestibular Sensations.*—This term is used because it involves in pure form the subject's relationship to space—reminiscent of, if not identical with, the vestibular aura common in psychomotor seizures.

In one instance a feeling of giddiness occurred, which quickly changed into a feeling of soaring off into space.

There were many visual anomalies with an alteration of perspective associated with feelings of propulsion and retraction—such an anomaly was a mixed visual-vestibular one.

5. *Bodily Sensations.*—Such changes occurred in 17 cases, and the descriptions of these anomalies are noteworthy for their great variety. It should, however, be noted that only rarely were changes spontaneously reported. These came out usually upon questioning, accounting perhaps for the fact that other authors have not reported a similarly high incidence of changes in body sensations.

The commonest occurrence was a difference in the way one part of the body felt as compared with the rest. The following descriptions will be given to indicate the range of abnormalities noted.

"I can't use my left arm, which feels strange; it has a disconnected feeling. It's flexible and it feels more elastic than the other, and it also feels busier. When the light shines on my limbs, the left looks bigger."

"It seems to me that my body feels different depending whether my mouth is open or closed, or whether my legs and arms are crossed or uncrossed. The left arm and leg feel different; their color is different and the right side appears to be more connected to my body. I also have a feeling as if I had a hole in the middle of my forehead."

"Both arms and legs feel detached. The right one more than the left. The left foot appears to be half as long as the right. I am not conscious of my throat between my head and body."

"My teeth feel numb. My right arm feels stronger, and my right eye definitely feels swollen every time that the light shines on it."

"The ulnar half of my left hand feels different, detached, and it gives me the feeling that I could not perform with it as well as with the rest of my arm."

"The right half of my body feels as if it were 6 o'clock in the evening, whereas the left one feels as if I had just gotten up early in the morning."

"I feel numb from my teeth up and it feels as if that small top part of my body would be completely covered by hair."

"The left arm feels numb, pulled into a knot. It appears thin when the light shines on it, more so than the right, and my whole left side is very suggestible. Whatever I think about it, I feel it right away."

"My body feels completely apart from my brain, and, incidentally, this is a very happy feeling. My abdomen feels disconnected from the rest of my body, and when I use my right hand to write with, it feels disconnected."

### C. Synesthesiae

This term will be used rather loosely in the text to describe phenomena characterized by one sensory experience influencing another. In 14 cases—as the complexity of these sensory cross influences increased—a paranoid type of schizophrenic reaction occurred, the evolution of which could be followed (and predicted) step by step. Hence, a detailed treatment of these experiences is deemed to be important.

As mentioned before, in every instance hand clapping, or some such noise as that, was able to change invariably the form of the images, and only seldom was it also capable of changing the color. When the kaleidoscopic illusions had sharp angles, hand clapping would smooth out the angles and turn the fingers into curved ones, which then stayed that way for a while. If the subjects happened to see, however, curved images at the time of hand clapping, these never turned into angular ones; but, rather, they began to coalesce and their color change in some cases.

Optic sensations were most commonly influenced by auditory stimuli. It should again be emphasized that the emotional reaction of the subjects to the influence of random noises (including distant church bells) on their visual sensations was not considered disturbing, but when the auditory stimulus was the voice of the inquiring observer, the subjects began for the first time to become anxious, and from this point on usually anxiety increased, as illustrated by the following examples.

The subject (A) saw Mexican peons wearing sombreros on donkeys dancing on the wall, which after a while would vanish, but then the wall would "breathe" in and out at a rather rapid rate, not coinciding with the subject's own rate of respiration. When the observer, at this point, asked her to continue to describe what she was seeing, she began to complain that the examiner's voice was responsible for these changes; that the "breathing" of the wall followed exactly the examiner's voice, high sounds causing the wall quickly to retract and deep ones causing it to advance slowly forward. Random voices in the background were doing the same thing, causing the "breathing" of the wall to speed up and become extremely disorganized, and, at this point, the patient began to complain that the background voices were "talking terrible things about her." This, then, marked the beginning of a frank paranoid reaction, in which the members of the investigating team were placed in the category of "persecutors who have nothing else to do but to drive the subject out of [her] mind." When she was asked if she really believed that this was so, she admitted that she knew perfectly well that this was part of the experiment but she could not dissociate herself from this conviction. Her attitude became one of annoyance and negativism, which persisted during the rest of the experiment.

Another subject reported a series of experiences which started at the precise moment that Card 2 of the Rorschach test was shown to her. This rare case did not proceed, however, to feeling persecuted:

"As I look at this card I see cream-colored, long towers which, whenever I hear the church bell—

like now, for instance—break up into ever so many little towers, but at the same time the color changes from cream to brown. At this moment, the towers coalesce (as you clapped your hand) into brown scrolls, and then everything on this card appears in a light-blue color. Now that you said 'Card #3,' I all of a sudden see music in the card which I can recognize as being a sequence from the "Bald Mountain Suite," but I don't hear the music—I see it in the form of mountain ranges interconnected by iron bridges." (This sort of experience obviously defies description.)

The influence exerted by the examiner's voice on the subject's body sensations likewise caused anxiety, often admitted to with reluctance, and this feeling apparently acted as the precursor of a subsequent reaction of paranoid coloring.

(Subject B) "I feel that my left arm is strange, disconnected, pliable, and it appears to be busier than the right side. When you talk about these sensations, however, these sensations leave me. I am frightened by the amount of influence that you have on my feelings, and I resent the fact that I am kept here against my will. I resent the fact that I am suggestible; I know you have fouled me up here, and I demand that you give me some ice that I could put in my left hand to get rid of that strange feeling. You are upsetting me by allowing people coming into this room, and they seem to come in only when I am talking. Why isn't there something done about this?"

The same subject had, at the conclusion of the experiment, reported that the left half of his body, including every organ, felt detached and entirely different from the right, as if he had been split into two and put back the wrong way. Even the left hemisphere of his brain felt different than the right. In addition, he had that feeling that up to the hip he had been suspended in a rubber tube. This split feeling persisted for 12 hours after the conclusion of the test, and it reportedly terminated suddenly, when, at that time, during a sexual act with his wife, he experienced an orgasm.

It was a short jump from complaining that the examiner's voice influences vision or illusion or body sensation to the more annoying complaint that the voice presently subjugates thinking and, finally, that the examiner's thoughts control the subject's thinking. Thought control was associated invariably with a hostile, conspiratorial trend.

When frankly persecutory ideas were admitted, the first target was the examiner; later on, however, all members of the team—in fact, everybody present in the room—was included. There has never been any doubt, however, that, of all the members of the investigating personnel, the No. 1 enemy was the senior author.

One subject, for instance, first complained that the interrogating psychologist was purposely irritating him. He then proceeded to admit that people whispering and walking around in the background were likewise in the league with an aim to annoy and upset him. When he was asked, however, how he felt about the senior author, this subject (C) snarled and spat out in space. It thus appeared that when synesthesiae led to ideas of thought control and influence, the referential ideas quickly went over into frank paranoid delusions. Insight, however, was never lost, but for the first time the subject had great difficulty in maintaining a detached objectivity about the experiment.

Another subject first noted that the psychologist's voice exerted an influence upon his thinking as he was presented the Rorschach cards, at which point he stated, using a language that became more and more reminiscent of that encountered in schizophrenia:

"I feel persecuted. I have no idea what goes on. I don't want to answer. I don't seem to be able to dissociate these cards. The color red means something that is interesting. I do not feel like answering. I already had suspicious feelings when you gave me a milk shake; I was not able to pull out the straw. I suspect some kind of a trick. I have a fear of losing control. I think you all want to confuse me. I resent that I am suggestible and that I can be talked into everything. I am getting fond of these cards the way one gets fond of one's mother. I think I simply learned to hate you all. I resent the way you talk to me; it's just a lot of 'ice cream' talk."

Another subject reported that the left leg felt lighter than the right; it also felt more excitable, and the excitement was directed and provoked by the examiner's questions.

At this point the subject burst out with this:

"I suspect a trick. I have the feeling that what I say is unimportant and it's not going to be written down. Everything here seems to be up to the psychologist; what he thinks is important will be written down. I feel I am discriminated against."

Another subject admitted anxiety for the first time when he noted that his own words changed the Rorschach picture, and, after he had remained silent for a while, he stated that he was scared to admit this. At this point, while he was protesting against the examiner's allowing such strange influences to prevail, he also said that he was very uncomfortable and that "the place smells as if it would explode any minute."

One subject acted hypomanic and gave 25 to 30 responses to Rorschach Card 5. He then complained of feeling a hole in the middle of his forehead, and that the examiner, while talking, blew the cold air of his breath into this hole, thus influencing the functioning of the subject's brain and his thinking. He suddenly became morose and taciturn, and when the usual lunch was presented to him, he refused to eat. When asked why, he gave a series of excuses. First, he objected to the straw in the milk-shake cup, claiming that it appeared to him about one mile long. Next, he claimed that he was not capable of eating in a lying-down position, even though he was propped up and covered with an oilcloth bib. He then "frankly admitted" that he was not hungry. It was only after the experiment was concluded that he stated the real reason, namely, that he had the feeling that the food was being poisoned. He gave only four responses to Rorschach Card 5, and all the subsequent responses remained under five per card.

In all instances save one, such a reaction was over at least within three and a half hours after the ingestion of the drug. This particular subject (C), one hour after the conclusion of the test, was standing in front of the building participating in a group discussion (not about the test) when the senior author noted that he kept a distance of approximately 6 ft. from the cluster of five people involved in the conversation. When he was asked about this, he came forward by 3 ft., drew an imaginary straight line with the heel of his shoe on the concrete, put the tip of his shoe on top of the line, and claimed that if he would push his foot one inch beyond the line in the direction of the senior author, he would immediately experience the feeling that he "hates [his] guts."

### D. Persistence of After-Image

The persistence of the after-image was very markedly increased in 15 instances. This increase coincided with a marked prolongation of the alpha perseveration time (the period during which alpha waves were blocked after visual stimulation). In one instance, the after-image persisted for two minutes. The average increase was 10 seconds. In all but one case it was the positive after-image that persisted. In one case, however, the negative after-image persisted for eight seconds.

### E. Distortion of Time Sense

Time sense was found to be distorted in 14 cases. In 5 of these 14 cases time appeared to be elongated. In six cases it was speeded up, and in the rest of the cases it appeared to be slowed down at first and then speeded up to the remainder of the experiment. This cyclic variation could not be correlated with a hypomanic-depressed emotional reaction cycle. Quite a few subjects were able to follow the passage of the time by counting the sound of a bell of a nearby church. When they were asked to give an opinion about the length of time that they had spent in the laboratory, they would say that, even though they knew exactly how much time had elapsed since they came in, it still appeared to them either much longer or much shorter on the basis of their own subjective experience of the duration.

### F. Disturbance of Ego Sense

The ego boundaries were disturbed in varying degrees, under various conditions, at various dosages, and this state persisted for various lengths of time. A feeling of deper-

sonalization and estrangement of a vague character was noted in six subjects, while in another seven these disturbances occurred as an elaboration of the changes that interfered with their visual perspective, and, even more frequently, they were connected with anomalies of their bodily sensation. It seemed as if the ego boundaries were very sensitive to such subjective experiences, to which they reacted with anxiety. The subjects complained that when they were left alone they feared "impending dissolution." Two other patients, however, became exhilarated, as a result of their "all-pervading expansion," and insisted on being left alone to enjoy this state of "floating," or "lightness." For short flashes many patients noted tendencies toward dissociation and self-observation, and one subject pictured himself as the statue "Thinker" by Rodin, with his head propped up in his palm, watching himself undergoing the strange reactions. Feeling of impending ego dissolution occurred mostly in subjects who had relatively large doses. In one subject various degrees of this distortion persisted for over 24 hours.

### G. Language Changes

Apart from a definite tendency toward playing with words in various ways, sometimes associated with forced laughter, instances of echolalia were common. The most characteristic language change, however, was condensation of words, consisting usually of uniting the first half of one word with the second half of its opposite. Sometimes a simultaneous feeling of opposite impressions was reported—for instance, "I feel as if I were going up and down in the elevator at the same time," or, "I feel as if I were lying down and standing up all at the same time." This sometimes was extended even to the description of images evoked by the Rorschach card—e. g., "I see the south side of a broad-beamed burlesque queen going north and I am standing in front of her."

Many examples of random condensation of words were picked up from the sound track. One example was "mopher," a condensation of mole and gopher. Instances of a tendency toward alliteration were likewise noted, as, for instance, when describing a Rorschach picture, "This looks like the late, lamented esophagus."

In general, the language changes were very similar to those that were reported by several authors, more particularly by Brickner,[38] who studied the tape-recorded production of subjects who were under deep amobarbital (Amytal) sodium narcosis. Condensation and confusion over opposites and over choice between these opposites were not only expressed in language but were openly admitted in the thinking of the subjects. Most of them felt the simultaneous opposite feelings mildly annoying, though these were not limited to paranoid reaction cases.

There were only two subjects who used the typical peripheral circumlocutions noted in amnestic aphasia. The music coming from a Good Humor man's car was described as "church bells on wheels." Another called a cigarette "smoking stick."

### H. Motor Symptoms

Twitching of the muscles of the leg was reported in one instance; facial and eyelid twitches, in another instance. Choreiform hand movements were present in one case. Tremor without chill was present in one case; tremor with chill was noted in another instance, but the tremor outlasted for several hours the disappearance of the chill, and it was limited to the upper extremities.

All subjects were tested for reflexes before and during the test. In 10 instances hyperreflexia of a generalized character, without any pathological reflex activity or lateralization, was noted. Left hyperreflexia was noted in two instances. Since these subjects were lying in bed throughout the test, gait and station were not tested.

### I. Emotional Reaction

A variety of emotional reactions occurred in every subject, to some extent. Euphoria throughout the experiment was the case in eight subjects, who spent a considerable amount of the time in giggling and in boasting about their wonderful feeling. In only

two subjects was depression the prevailing mood throughout. In all the other subjects mood was variable from one time to another, usually starting out with euphoria, forced laughter, and giggling, and turning into anxious preoccupation at the height of the experiment, especially when this was the forerunner of a frank, disturbed, suspicious, paranoid, dysphoric reaction. Anxiety was anticipatory in some; others, however, described the feeling as if their anxiety were an after-reaction to something terrible that had happened to them—as if they had undergone a big scare, which, however, was now over.

Without exception, the subjects who developed paranoid reactions admitted, not during the experiment but later on, that at the height of their reaction they had fear of losing self-control and of becoming violent. Even the euphoric subjects admitted to small annoyances which interfered with their "enjoyment" of their perceptual anomalies, or else they had the feeling that the variety of their subjective experiences were not taken too seriously. One such subject, for instance, resented the fact that his remarks were always written down on the margin of a white sheet of paper. Most of the subjects commented on the extraordinary redundancy of their perceptual anomalies or of their thoughts, and, while they protested that they were trying their best but could not keep up with words in their attempt to describe what they experienced, a few felt sorry for all the people who missed this extraordinary experience.

### J. Tapping Rate

The subject's ability to tap at maximum speed with both hands was part of the study. This was recorded on a wire recorder, and measurements were made at the height of action of LSD and compared with the control values. It was found that, on an average, in right-handed persons the tapping rate on the right side was 120 for a 10-second period, as compared with 110 on the left side. The control figures were 90 and 80, respectively. This would indicate, then, an increase in tapping rate while under the influence of LSD. No change in the pattern was noted.

### K. Handwriting and Drawing

LSD produced insignificant distortions in handwriting, but ability to judge size, distance, parallelity, and angles in drawing was impaired as compared with the control samples.

### L. Retention and Recall

Every subject, at the height of the test, was given 10 test words, with the explanation that the subject's speech was being examined. In 14 instances, only 3 or fewer out of 10 test words were recalled after three minutes. In another six instances, 4 out of 10 words were recalled, which was considered borderline, while in the remainder, of five cases, recall was within the normal limits.

### M. Electroencephalographic Changes

In the spring of 1951, when our experiments began, the consensus was that, however pronounced the effect of LSD-25 was on the psyche, the EEG remained normal. In 1952 Delay and associates,[27] however, injected LSD-25 into the veins of rabbits in amounts 25-600 times as large as the oral dose effective in man and reported a complete flattening of the record, with disappearance of the rhythmic elements of the animal's EEG. They, too, felt that in a few human cases the EEG remained unchanged.

The report of our experience with electroencephalography will be divided into several categories.

1. *Effect on Alpha Index* (22 cases).—Alpha index for our purposes is defined as the amount of alpha activity present in 100 seconds of record in a single channel (occipital) free from artifacts. As stated above, on occasions when the subject reported a particularly vivid or unusual hallucination, the EEG was recorded. Inasmuch as the experience described was sometimes anxiety-laden, there occurred, understandably, a more or less complete blocking of the alpha activity and its substitution by desynchronized low-

voltage fast activity. When, however, the alpha index was determined at the time when the drug had its maximal effect and was compared with the control one, a strip of tracing was chosen when the patient was merely lying motionless in a darkened cage, not reporting any hallucination or delusion in particular. It was felt that such a strip would be more nearly representative of the background activity under maximal drug effect.

While the frequency of the background varied within the normal limits, alpha definition was affected in 18 out of 22 cases. Decrease in alpha index (11 cases) was 30% (range 20%-90%). Increase in alpha index (7 cases) was 50% (range 10%-70%).

In those cases in which decrease in the alpha index occurred two patterns were observable. In some cases the reduction of alpha activity was limited to the occipital areas, which remained that way throughout the experiment. More frequently, however, the normally present central (Rolandic) low-voltage beta pattern began to spread until finally the whole cortex became devoid of alpha waves. There was a time when the parietal alpha activity was gone while the occipital areas were still exhibiting synchronized alpha activity. Therefore, it would seem that we were not dealing with a sudden process of desynchronization, such as occurs in visual or mental stimulation—affecting the EEG in toto—as would be expected in anxiety. Rather, there was a gradual spread in the relative displacement of the alpha pattern, much as is seen after intravenous barbital administration, though without the characteristic monorhythmic fast activity seen in the latter.

2. *Abnormal Activity.*—In three cases large (up to 150μv), 6 cps bursts swept through all the leads, in the absence of drowsiness.

3. *Paradoxical Activity.*—Gibbs has described the appearance rather than the blocking of alpha activity in response to light stimulation or opening of the eyes in drowsy subjects. This was seen in four of our cases, but drowsiness here could not be ascertained (Fig. 1).

4. *Response to Single-Light Stimulation.*—Every subject was given 30 single-light stimuli in a darkened room with eyes closed. The perseveration time—the interval between disappearance and reappearance of alpha waves—following the 0.2-second light stimulus was determined before and two hours after the administration of the drug. Perseveration-time average before drug administration was 0.41 second; perseveration-time average after administration was 0.90 second. Alpha blocking was therefore over twofold prolonged. This might tie in with the clinical observation that the time of persistence of after-image was frequently elongated—at times to two minutes.

5. *Deactivation in Response to Hallucination.*—It was known that during the visual hallucinations provoked by mescaline the well-synchronized alpha activity of relaxation was brusquely replaced by a deactivated low-voltage fast pattern. This observation was more than confirmed when working with LSD. In two subjects who had primary visual hallucinations in the right half-field only, the left occipital alpha was absent while the right one was prominent. This ceased immediately with the disappearance of hallucination (Fig. 2).

Delay [27] and others were able to bring back bursts of normal rhythm in the flat, deactivated record of their rabbits under the LSD effect with the intracarotid administration of 40γ/kg. of acetylcholine. This would suggest that the mechanism to account for focal deactivation might be due to regional vasospasm.

6. *Response to Tactile Stimulation.*—In a previous work [34] we reported on the effect of tactile stimulation by graded air blast on the spontaneous electrical activity of the cortex. In some subjects, after a long latency (one second), bursts of fact activity (18-22 cps) appeared for 0.36 second (when the stimulus lasted 0.2 second) bilaterally without desynchronization of the occipital alpha waves. It was thought that this represented

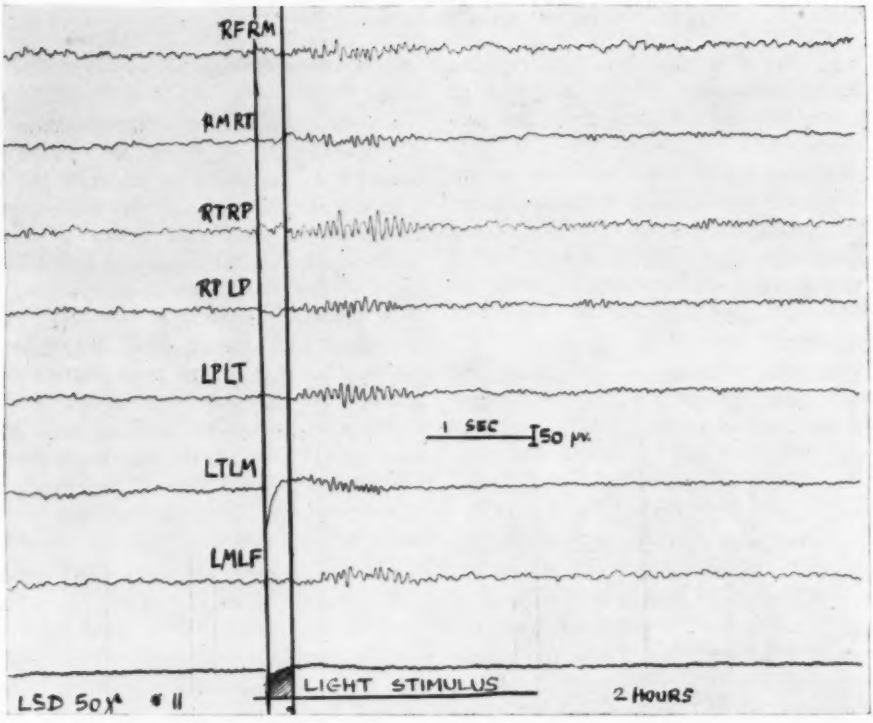
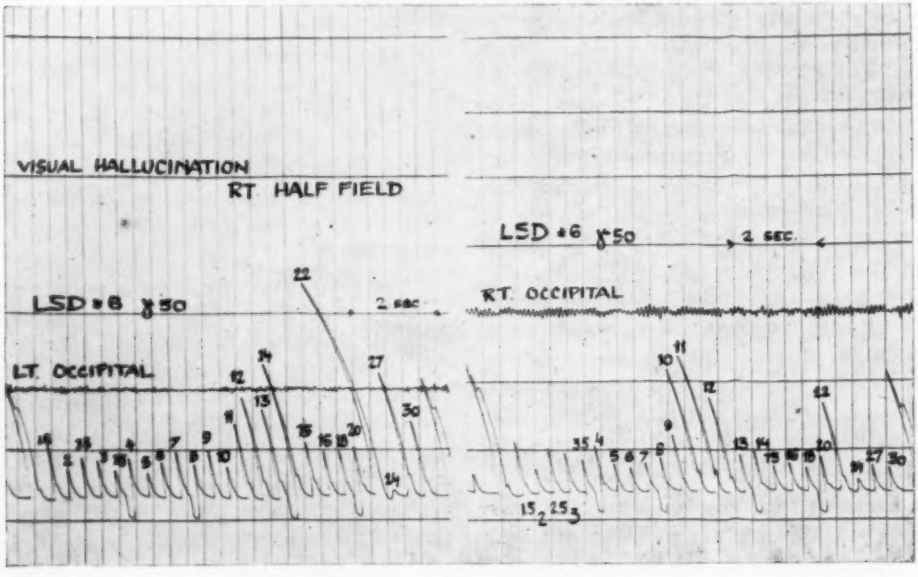



Fig. 1.—In some cases the effect of a single-light-flash stimulation of 0.2 second's duration produces a paradoxical effect, consisting of the sudden return of alpha activity, rather than its blocking, in a nondrowsy subject, whose alpha activity shows reduction at the end of two hours following administration of the drug.

Fig. 2.—Desynchronization of alpha activity in the left occipital area only, coincident with the occurrence of visual hallucination limited to the right half of the visual field.



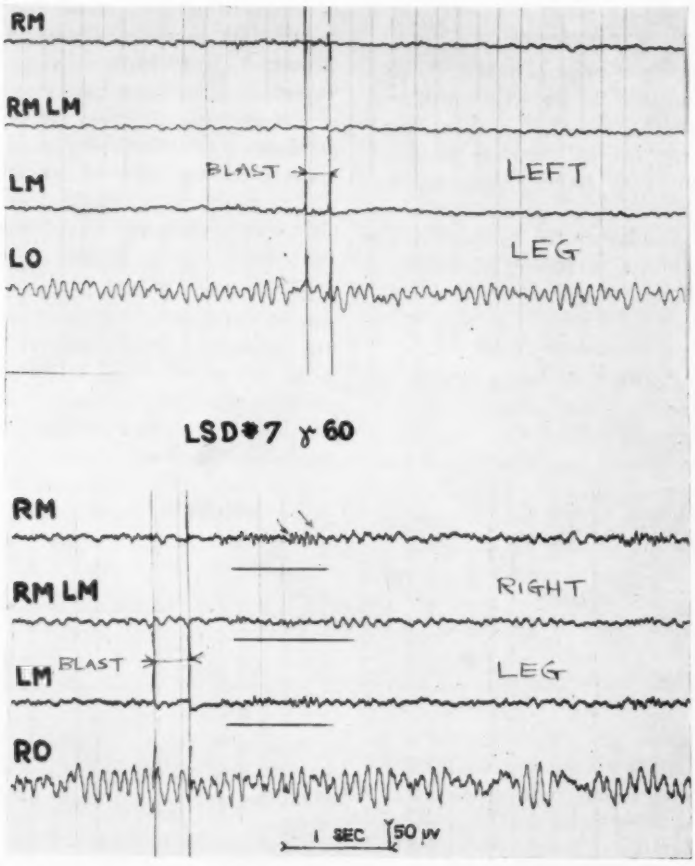



Fig. 3.—Response to tactile stimulation of 0.2 second's duration in a subject who claimed inability to perceive feeling in the left half of his body. Graded air blast applied to the left leg caused no change in the EEG, while the same stimulus of 0.4 second's duration, applied to the right leg (which he was able to feel), produced a rebound, delayed fast burst bilaterally, after a short latency. When this change in body sensation disappeared later, the fast bursts appeared when either leg was stimulated.

a secondary rapid after-discharge and the rebound return of the central beta pattern. Four out of the six subjects originally used for these experiments, when given LSD, developed a delusion of body scheme involving the left side of the body, which they were unable to feel and which "did not belong to them." When the air blast was applied to that side, no change was noted on the EEG on either side. When, however, the tactile stimulation was applied to the uninvolved side, which they did feel, the fast bursts were clearly observable (Fig. 3). This suggests that some blocking takes place in the proprioceptive feedback mechanism that operates in this area, which, as Gastaut has shown, is sensitive to proprioceptive, exteroceptive, and even associational, influences.

Findings such as this tend to emphasize that the EEG is related to the functional organization of the brain and is not merely a side-product of brain activity. More particularly, evidence appears to be present to the effect that the cortex has an ability to distinguish between internal and external stimuli in that it seems to be refractory to

external stimulation when it is busy, as it were, for internal consumption.

In conclusion, it appears that LSD produces an alteration in the EEG, with only rare abnormalities outside the alpha range. It is to be expected that the widespread disturbances in mood, feeling tone, alertness, reality testing ability, and perceptional acuity are bound to influence the behavior of the spontaneous electrical activity of the brain, if only in response to various sensory stimuli.

### N. Rorschach Tests

All the subjects were tested, but, owing chiefly to the disruptive effect of LSD on test procedures, in only 13 cases was it possible to correlate the drug and control tests. The detailed description of our findings will be described in a later article. In general, there appeared to be potential indices in the control test that could predict a psychotic reaction—the kind of reaction, however, was considerably less precisely foretold. Paranoid and nonparanoid forms of schizophrenia reactions exhibited scores that were not widely differentiated. With one exception, however, the occurrence of complex synesthesiae in the 14 cases that developed paranoid-like reactions acted as a more reliable precursor of the feeling of being persecuted. Our impression was that both psychopathological and pathophysiological factors mattered in the development of the paranoid reaction.

## COMMENT

At this point, we are in a position to inquire about the working mechanism of this drug.

### A. Biochemical Aspects

There is a general agreement among all the authors who have experimented with LSD-25 that the resultant psychosis model is of the acute exogenous type in the sense of Bonhoffer, as described in 1908. This author assumed in psychoses the existence of a toxic substance arising in an organ that is damaged, or even in the metabolism of the brain itself. He called such toxins "etiological intermediary products." Such an assumption had its starting point in the finding that in certain liver diseases and in some conditions associated with brain damage increased values of certain amino acids were detected in the cerebrospinal fluid. In a variety of psychoses tryptophan could be demonstrated in the spinal fluid with the help of glycoxylic acid as the reagent. The presence of tryptophan is believed to indicate cell damage in the cerebrum.

Blickenstorfer,[37] who has made the most thorough analysis of this problem, postulates that acute exogenous reaction types may occur as a result of starvation, exhaustion, cachexia, fever, and cerebral circulatory embarrassment; and to the toxins due to tissue breakdown must be assigned an important role, besides the parts played by inherited constitution and by psychogenic factors. The question is whether the role of toxins is etiological or pathoplastic.

The infinitesimal amount of LSD sufficient to produce profound selective involvement of the central nervous system is meaningful. If no known measuring method can quantitate the LSD concentration in the body, it is hard to dismiss the possibility that in the psychoses some such substance in likewise small (tracer) amount might be the offending agent.

Fortunately, we do have of late a biological method that can at least affirm the presence—if not measure the amount—of LSD in the body. Witt [26] selected a spider (Zilla-X-notata) as the subject of standardization, because it has a central nervous system that is both complex and simple and presents negligible variation from one to the other. Also, the building of spider webs can be objectivated (photography), and the speed of formation can be recorded. The spider-web test has been used previously for the detection of Pervitin and strychnine. As compared with the effects of another *psychoticum*, such as mescaline, the regularity and symmetry of the angles of the web are pronounced with LSD, and the speed of its formation is increased. The latter factor is attributed to a better utilization of sensory

stimulation. The marked differences between mescaline and LSD in their respective effects on the spider suggested to Witt a possible difference in point of pharmacological action, which is all the likelier as the effects of these drugs on the human also present definite differences. The suggestion is obvious that the body fluids of normals and psychotics should be compared as to their effects on the spider, a study which is one of our present projects.

Abramson and Evans [24] recently found a specific psychobiological effect of LSD on the Siamese fighting fish and set up nine criteria with respect to changes in posture and state of consciousness that would permit use of the fish for a biological assay. No mention is made, however, on the effect of other substances on the fish in their preliminary report.

There is general agreement that certain psychotics are relatively resistant to the effects of LSD. Resistance cannot be attributed to the negativism, dissimulative tendency, and fluctuating emotivity of the schizophrenic, for instance—which might interfere with the reporting of LSD changes—since resistance occurs in all forms of psychosis. Those who report on hallucinations are aware of an alien addition to their "customary" hallucinations. One reason for this refractoriness might be the existence of LSD or LSD-like substance in large quantities in the central nervous system of psychotics, so that the addition of a few micrograms of substance is ineffectual. The effective dose is 1γ/kg. for normals and 3γ-6γ/kg. for psychotics.

Reference is made to the presence of tryptophan and like amino acids in the spinal fluid after concussion and other conditions of brain damage.

Tryptophan is a waste product of protein catabolism, and it is incorporated into the formula of LSD-25. Blickenstorfer points out that, while this may be incidental, on the other hand, it may also be considered an indication that LSD somehow appears in human metabolism. It need not be an alien substance. LSD can be partially synthetized out of amino acids, such as tryptophan, two dipeptides, and two tripeptides, which are all normal metabolic products in the human.

There is evidence that some hallucinogens, such as mescaline, form bonds with liver proteins at the time of their maximal effect. Block [33] has shown the inclusion of radioactive mescaline in the liver protein of mice in vivo and adopted the working hypothesis according to which hallucinations found in men originated by mescaline are due to this union of mescaline with body proteins. The moment of appearance and the duration of hallucinations were in agreement with the formation, high-point, and destruction of mescaline-protein. He is of the opinion that it is possible that schizophrenics are suffering from an enduring intoxication by amine proteins, due either to the changes in the amine oxidase system or to the absence of an inhibiting agent. In normals, protection against such protein-amine unions is furnished by the aminoxidase system, an inhibiting factor, and the cell membrane.

Fischer [39] studied the affinity of mescaline, Methedrine, LAE (lysergic acid monoethylamide), and LSD-25 for wool, and found that wool absorbs them in the same ratio as they precipitate model psychoses in normal subjects (500 mg., 100 mg., and 100γ, respectively). All these substances produce initial sympathetic hypertonia, followed by peripheral adrenergic blockage, before psychotic symptoms appear. The higher the initial sympathetic overactivity (stress or the shock phase of the general adaptation syndrome of Selye, or administration of 1 mg. of atropine prior to LSD), the lower the dose of the drug needed to produce a model psychosis. Possibly, persisting stress, causing first sympathetic and later on parasympathetic overactivity, tends to increase the dosage of LSD necessary to produce psychotic symptoms (such as hallucinations) which may serve as an explanation for the resistance of psychotics to doses of LSD effective in normal subjects.

Besides bringing into play the adrenergic factor in the biochemical working mechanism of LSD, this study also points out the

analogy between keratin of high sulfur content (wool) and the protein component of certain cell membranes which may be the structural target surface involved in psychoses.

According to Mayer-Gross,[8] LSD-25 seems to interfere with carbohydrate metabolism as well. He found a transitory rise in blood sugar and blood hexose monophosphate in normal subjects subjected to LSD, while the other stages of carbohydrate metabolism were not modified. Although this finding is still awaiting confirmation, this author theorizes that LSD, by an antienzymatic action, interferes with the splitting of sugar to the hexose monophosphate stage. Intravenous injection of 33% dextrose suppressed the LSD effect, and large amounts of glutamic acid likewise acted as an LSD inhibitor. The effect of dextrose is significant in that, if glycogen metabolism is blocked at the hexose monophosphate stage by LSD, and if the psychotic state is related to this, the direct administration of dextrose, which would by-pass the hexose monophosphate chain in order to be utilized, would be expected to have an inhibiting effect on the psychotic symptoms. Optic illusions, feelings of estrangement, euphoria, disturbance in concentration, and various perceptual anomalies did in fact become modified, and, to some extent, they tended to disappear. Since Mayer-Gross and associates did not consider clearly demonstrated a relation in time and severity between the psychological symptoms and the biochemical changes, they repeated their experiments on 13 hospitalized schizophrenics,[41] in view of the fact that such persons have a considerably greater tolerance for the drug and, consequently, they may show only minimal psychological symptoms after the usual oral dose. Eighty micrograms of the drug produced slight psychological effects. Yet hexose monophosphate showed a rise of 1.46 mg. per 100/ml., whereas under control conditions, when water was given, the mean value fell by 1.17 mg. per 100/ml. Mescaline, when given to normals, has produced a psychotic picture rather similar to LSD without a similar rise in the blood hexose monophosphate level. In vitro experiments with tissue brei showed that LSD-25 stimulated the respiration of brain tissue, whereas this was not the case when the tissue was that of the liver of guinea pigs. The authors, therefore, concluded that LSD-25, both in vitro and in vivo, has a sparing effect on hexose monophosphate metabolism, which is greater in the brain than in the liver, and in this respect it reacts unlike mescaline hydrochloride, which has no effect on blood chemistry, even though it is just as capable of producing a psychotic state in normals.

Liddell and Weil-Malherbe [42] have studied the effect of LSD-25 on plasma epinephrine levels and blood sugar concentration in patients suffering from psychoses, as well as in patients with psychoneuroses, and found that there is an initial rise of the epinephrine level, followed by a drop below the starting point and, finally, a secondary rise in epinephrine. The moderate increase of the blood sugar concentration was not considered to be significant.

Rinkel and associates [43] are likewise of the opinion that LSD may interfere with a major enzyme system. They consider the epinephrine system the most important. This is suggested not only by the marked sympathicotonic effect of the drug but by the observations made by Witt,[26] who, when feeding LSD to spiders, noted that each thread was much thinner than those in the control, leading to the speculation that this might be due to the exhaustion of the epinephrine supply of the spider, it being known that the spider web consists almost exclusively of epinephrine. Rinkel recalls the findings in animals by Heirman in 1938, according to whom a metabolite of epinephrine, called adrenoxin, had systemic effects similar to LSD, and an observation of Osmond and Smythies, who, in 1950, reported that an earlier epinephrine metabolite, adrenochrome, known for its hemostatic effects, which showed structural similarly with mescaline, produced dramatic psychotic

phenomeña in self-experiments. Rinkel was not able to duplicate this observation. However, he is of the opinion that the solution used by the above authors was deteriorating and thereby may have been contaminated by a further epinephrine oxidation product, namely, adrenoxin. He speculates that adrenoxin, a natural metabolite of the decomposition of epinephrine, may be operative in psychosis.

The recent findings of Marrazzi [32] further attempt to enlarge our knowledge about the behavior of epinephrine metabolites and similar substances with respect to their effect on the central nervous system. He found that in cats epinephrine, arterenol, and epinephrine preservatives cause synaptic inhibition, as measured by the decrease in the postsynaptic surface-negative wave, without affecting the presynaptic positive wave. This finding was obtained when stimulating one point of the cat's occipital cortex and recording from the symmetrical point on the other side, which two points are connected through the corpus callosum. He found a similar synaptic inhibition when using such hallucinogens as amphetamine, mescaline, LSD-25, adrenochrome, and serotonin, all showing structural similarity to epinephrine. An incidental observation of his was that serotonin, which was considered by Woolley and Shaw,[31] on the basis of systemic antagonism in animals, as an LSD inhibitor, in his experience had the same effect as LSD on synaptic inhibition. He considered the effect of LSD and other hallucinogens on a group of synapses as typical of a more generalized effect and concluded "that the resulting pattern of over-all activity would be a function of the variations in synaptic thresholds." If further experiments show that LSD affects the occipital cortical synapses differentially, then an explanation may be at hand for some findings which at the moment appear to be puzzling. It is well known that in LSD intoxication visual perceptual anomalies far outweigh the involvement of other sense organs. Alpha blocking following single flashlight stimulation is markedly prolonged in subjects receiving LSD, as compared with control experiments, when the stimulus is visual. Not so, however, when alpha blocking is achieved by other stimulation. Likewise, we have found that persistence of afterimage, when the eyes were closed, very striking, whereas the echo-effect of other sensory modalities proved to be insignificant. The special affinity of LSD for the occipital cortex, which, incidentally, may apply also to mescaline, still has to be confirmed by comparison with the behavior of other synaptic systems.

From the first description of the marked psychotic effects of LSD and the observation that the threshold of psychotics to these drugs is much higher than that of normals, a widespread investigation was directed toward the discovery of LSD antagonists. It has been known that very large doses of barbiturates, or intravenous dextrose, had at least a partial or transitory LSD-blocking effect. In the hands of Hoch, chlorpromazine, as well as a combination of amobarbital sodium and metamphetamine, behaved similarly. Agnew and Hoffer [46] found the effect of intravenous nicotinic acid to be LSD-blocking, while Himwich showed that Frenquil (α-4-piperidyl diphenyl carbinol hydrochloride) has an antagonistic effect on the EEG of rabbits receiving large doses of LSD.¶ Serotonin, with a definite antagonistic effect systemically, failed to overcome the neurological effects of these drugs. Fabing [44] reported on the partially and transitorially antagonistic effect of pipradrol (Meratran) on LSD psychoses in men, while the same drug has a beneficial, euphoria-producing effect in patients who suffer from depression and thus is likely to exert its action on the hypothalamus. Hoff and Arnold [45] found that glutamic acid or succinic acid, which is found in the citric acid cycle, terminated the mental symptoms induced by LSD, and it has also been known that succinic acid temporarily relieved the acute symptoms of schizophrenics. These authors implicate the

¶ Discussion on LSD Symposium, American Psychiatric Association, Atlantic City, May 12, 1955.

carbohydrate metabolism in schizophrenia and in conditions induced by LSD, being of the opinion that a disturbance in carbohydrate metabolism may exist in certain circumscribed areas of the brain, possibly in the posterior hypothalamus. It is of interest that patients with damage to this region of the brain were resistant to LSD.

From the available biochemical data, it appears that at the present time the widespread experimental and speculative findings cannot explain the action of LSD satisfactorily. The problem, however, is far greater than the biochemical working mechanism of a drug that is capable of producing psychosis. It ties in with the much more important problem of the biochemical foundation of at least some psychotic states. The ever-greater inclusion of an increasing number of disciplines in psychiatric investigations clearly points to the necessity of integration and synthesis of a great mass of scattered information.

### B. Neurophysiological Aspects

Comparison of the LSD state with intoxications produced by other, better-known agents shows similarity and, at the same time, a very definite measure of difference, which puts LSD in a class of its own among the experimental psychotic agents.

All the other agents except mescaline had in common the necessity of using relatively large amounts in order to produce a model psychosis.

In the mescaline state, psychic functions, more than any other, seem to be affected, and the resultant model psychosis appears to be more stereotyped and therefore more predictable. Eidetic phenomena are very much in the foreground as compared with other systems. Catatonic-like schizophrenic states are more prevalent than the other forms. Mood is characterized by dysphoria and anxiety, the latter outlasting by as long a period as one week the administration of the drug. There is even a stereotyped response of the EEG in mescaline intoxication in that the substitution of synchronized alpha rhythm by desynchronized beta activity likewise may go on for several days in fairly good harmony with the state of anxiety which it reflects.

The peculiarity of the LSD model psychosis is the infinitesimal amount of drug necessary to produce a psychosis, which is approximately one-hundredth that of mescaline—an indication of a formidable degree of affinity. Considering the very profound psychotic-like changes produced by LSD, it is surprising how minimal is the interference with intellectual function, a fact which underscores its similarity with the undeteriorated schizophrenic reaction. The LSD psychosis is also noteworthy for its relative sparing of the corticospinal and of the cerebelloextrapyramidal system.

In attempting to localize the possible site of origin of the various psychic manifestations of LSD, on the basis of analogy, most of the symptoms reported are reminiscent of the sensory seizures or psychosensory seizures commonly seen in "psychomotor" epilepsy, and which were reproduced by cortical electrical stimulation by Penfield. This would suggest the primary involvement of the temporal lobe and its connection with the diencephalon. Very few of the phenomena noted in LSD psychosis would have to be localized elsewhere. Thus, for instance, the primary visual hallucinations, delusions, visions, and pareidolias bear a resemblance to the sensory seizures or sensory auras seen in that condition. Micropsia, metamorphopsia, and heteromegalopsia, which are so prominently displayed in the description of LSD psychoses, are elements of temporal lobe seizures, as are kaleidoscopic pictures, vertiginous attacks, and auditory and gustatory, as well as olfactory, perceptual anomalies. Auditory and visual reverberations, feelings of familiarity and unfamiliarity ("I had this test before"), based on both visual and auditory experiences, likewise fall into that category.

In psychomotor epilepsy, it can hardly be implied that the specific cell structures located in the temporal lobe gray matter, in and by themselves, are responsible for the reproduction of these phenomena when

electrically stimulated. They merely mark the starting point of an excitation traveling down in a circuit of neuronal chains of various complexity.

Unlike the situation in epileptic phenomena, however—at least when recorded from the intact skull—in LSD psychosis no evidence of synchronized excessive electrical discharge could be detected. It has to be noted, however, that even in psychomotor epilepsy it is not always possible, when recording in this fashion, to find the electrical sign denoting excessive neuronal discharge. Recording directly from subcortical or poorly accessible areas in a human brain (rhinal fissure, undersurface of the temporal lobe) often discloses that, owing to the distance of the recording scalp electrode from the site of origin of the discharge, the spike may not always be picked up, or else, instead of picking up a spike, sharp waves appear, indicating the amount of distortion that takes place when the spike is conducted in distance. The complete absence of any abnormal electrical event in LSD psychosis, even when the site of origin is presumed to be the convexity of the temporal lobe cortex, has been uniformly confirmed. LSD may have a special affinity for these structures, but, because the neurons of these structures are intact, there is no excessive discharge and resultant electrical abnormality. Consequently, the activation and successive involvement of the neuronal chains responsible for the LSD phenomena must have a different mechanism than the one that prevails in seizures. The fact that sometimes these phenomena are enduring, and even rapidly changing back and forth, and that they can be influenced by introducing other stimuli operating in other sensory systems (synesthesiae), further underscores the difference between the mechanism of LSD-produced brain phenomena and seizure phenomena. Occasionally, psychomotor epileptics, recognizing the threat on the basis of a sensory aura, may produce voluntarily a reflex counterstimulation, which, however, rather than changing the value of the sensory experience, merely terminates the aura, and, even so, not always.

The mood changes, which may vary from depression to elation in the same subject in the same experiment, may alternate from one to the other, along with such signs of emotional incontinence as seen in forced crying or forced laughter, suggest the activation of diencephalic circuits, possibly along the pathways of the two circuits for emotional expression originally described by Papez, although there may be many others.

These mood changes bring into mind the experimental findings by Foerster, Penfield, and Bailey, who were able to produce manic-like or depressive-like changes when mechanically stimulating the anterior or the posterior half of the floor of the third ventricle respectively.

The perceptual anomalies occurring in the somatosensory system, particularly those involving distortions and delusions of the body image, would implicate chiefly the postcentral parietal primary sensory receiving area, the surrounding associational strips, and the parietothalamic connections of the minor hemisphere, since most body-image distortions lateralized to that side.

The frequent complaints of numbness, particularly in the perioral area and in other midline structures, or the paresthesias prevailing in these same structures, are reminiscent of the sensory seizures, which are, in turn, localized to the secondary sensory receiving area.

In many cases a moderate defect in retention and immediate recall was noted, and it was also noteworthy that distortion occurred with respect to the correct appreciation of the duration component of time. There is a suspicion that the difficulty indicates interference with the recording element in the memory process, which, in turn, would suggest involvement of the amygdaloid complex. This structure may also be responsible for the reduction of sexual drive.

As mentioned under the heading of EEG changes, a marked increase in the average alpha perseveration time was observed in almost every instance. This means that, in response to a (visual) stimulus, the alpha blocking persisted for an inordinately long

time. This finding has to be combined with another observation, namely, the markedly long persistence of the after-image, either positive or negative. Since here the occipital alpha rhythm is involved, there is reason to believe that the disturbance affects those cells responsible for occipital electrogenesis, and that some synaptic embarrassment is responsible for the prolonged alpha perseveration time and for the long persistence of the after-image.

The peculiarities of the LSD language, showing condensations of words, often of opposite meaning, suggest some conflict or confusion over twoness and an embarrassment over a choice. While this area has not been properly investigated, the similarity between these phenomena and what one commonly sees in schizophrenic states is not the least striking effect of the LSD psychosis.

A special chapter ought to be reserved to explain the modus operandi of the synesthesiae, especially because in a fair number of cases they occurred in a sequential order and so commonly ended by producing a paranoid state.

Ordinarily, sensory volleys travel in "closed conduits," even when the peripheral receptors of the various sense organs are simultaneously and maximally stimulated. Though collaterals reach such widely separated structures as the ascending reticular system in the brain stem, the hippocampus, and the cerebellum as the volley passes corticopetally, normally these impulses do not discharge into one another.

In the LSD state it was quite striking how often one form of stimulus influenced the perception of another form, suggesting some "cross-talk" mechanism between the individual sensory pathways. One can speculate about the level where this mutual penetration may take place. Sometimes the synesthesiae were quite primitive and quite simple, suggesting, in turn, that the confusion originates at a subcortical, for instance, a thalamic, level. A good example of this would be the disappearance of the illusion of angular-shaped designs and their instant metamorphosis to curved ones upon simply clapping the hands.

A far more complicated synesthesia, however, is the one in which the subject reports that his voice or his perceptual anomaly referable to the somatosensory system is influenced by the examiner's voice. Here, the correspondence, or, rather, abnormal correspondence, probably takes place on the cortical level between one sensory associational or recognition area and another, sensory primary receiving area, or its correspondent association and recognition components. In the most complicated instances, particularly when these sensory disturbances are associated with annoying emotional reactions, the frontal lobe and its connections both to the sensory associational areas lying more posteriorly and to the diencephalon will have to be implicated.

Another possibility is that the critical area is of one of cross talk in the hippocampus. Recent work indicates that the hippocampus is the recipient of afferent volleys coming in from all the sense organs, and it has earlier been established that the hippocampus is a very important link of the two primary emotional neuronal chains described by Papez. It is, therefore, conceivable that the distortion in sensory perception in the form of a synesthesia, entering in confusion in the form of afferent volleys into the hippocampus, may give rise to a strong discharge, which then will travel in the aforementioned two circuits of emotional expression, leading either to a fear or to anger or to both. Accordingly, the dysphoria of the paranoid state may originate at the hippocampal level.

Probing of the personality make-up of the subjects often furnished poorly reliable, and even contradictory, indices for the prediction of a subsequent paranoid reaction, so that the assumption gained momentum that the paranoid schizophrenic reaction need not be considered as a distortion of an underlying personality so inclined, but, rather, may be the outcome of a perceptual

overload to which priority ought to be assigned in the hierarchy of stresses that an individual can tolerate. The delusional hallucinatory experiences of a paranoid nature induced by LSD enabled one to break this reaction down into its elements, study its evolution, as it were, "in slow motion," and observe the sequence of events leading up to the ultimate break.

Where general knowledge of the subject and the Rorschach test suggested confusion over sexual identification and repressed homosexuality, delusions of thought control and control over body sensations emanating from an examiner of the same sex could conceivably have set the stage for a homosexual panic or acted as precursors of a flight into a paranoid state to keep homosexuality from breaking into awareness. Paranoid inclination of male subjects was not interfered with when the examiner was of the opposite sex, though it must be stated that one of the women subjects (C) was always aware that she was under the direction of the senior author, of the male sex. Then, again, examined by the (male) senior author, three of the "paranoid" subjects were women.

There is an individual variation in frustration- and anxiety-tolerance, and such factors as individual sophistication might also explain this type of personality reaction to mental stress. It comes to mind, however, that experiments have been devised before in which the frustration- and stress-tolerances of individuals were put to severe test. For instance, subjects who speak into a microphone and then hear their voice through earphones with a certain amount of fixed delay describe the resultant confusion as being exceedingly unpleasant, at times leading to stuttering and to a great deal of anxiety, but we are not aware that a paranoid state resulted.

Considerations of dosage had to be discarded. Some of our subjects who developed paranoid reactions have taken only 0.5γ per kilogram, which is half of the average dose given by almost every author to their normal subjects.

In toxic-organic psychoses, especially when the state of consciousness is interfered with, the EEG shows signs of diffuse slowing, while in functional psychotic reactions no abnormalities are seen. In this respect, the LSD-induced psychotic state shows greater analogy with functional conditions, which would permit the speculation at least that both share the same substrate in the brain for which LSD shows the greatest affinity. On the other hand, least affected are those systems which form the core of the routine neurological examination and which utilize long tracts, such as the corticospinal, ascending sensory, and cerebello-extrapyramidal systems.

Many authors have emphasized the marked resistance of psychotic persons to such doses of LSD as are effective when given to normal subjects, though some observed such a resistance only in deteriorated cases.[9] This led some authors to assume that a LSD-like substance must already be present and in operation in psychotics; consequently, the addition of the infinitesimal amount which is effective in normal subjects, understandably, cannot possess any enhancing effect on the psychotic picture. As Condrau [13] has pointed out, the large doses merely increase the vegetative symptoms which set the limit of the amount of LSD anyone can tolerate. It is possible that in psychotics the same anatomicophysiological substrate that shows the greatest affinity for LSD is already involved; therefore, the resistance would be due to the fact that the substrate in question is already "busy" and, consequently, unable to react further to stimuli that are supposed to bear upon it by virtue of the circulating LSD. This explanation might be the same as that which would account for the common observation that psychotics rarely, if ever, change a psychosis, and that the development of one form of psychosis renders them "immune" to the development of another one. In this connection, an observation of Hoff and Arnold [45] may be pertinent. These authors have given LSD to patients with alcoholic psychosis. They have found that a great measure of resistance

to LSD exists in subjects suffering from delirium tremens. In Korsakoff's syndrome, the reaction to LSD was the same as in normals so long as the midbrain and medulla were intact. In alcoholic psychoses, with more widespread damage (cortex, thalamus, hypothalamus, mammillary body, midbrain, and medulla), the LSD effect was nil. These data suggest that some structures in the diencephalon possess an LSD-sparing effect. Fabing [44] reported the LSD-antagonistic effect of the drug pipradrol, which, clinically, produces euphoria in depressed persons, and, therefore, one can assume that the point of its action is in the hypothalamus. Once again, therefore, it appears that if part of the critical substrate responsible for LSD psychosis is busy and under stimulation by another chemical, then LSD will not be able to dislodge or modify this effect and, therefore, some of the most important symptoms of LSD psychosis will not find expression.

Sketchy as the data so far available may be, they rather impressively point to a complex working mechanism. Interference with several enzyme systems would be one element of the LSD effect, and its selective embarrassment of that part of the central nervous system which subserves psychic function would be the other.

SUMMARY

*d*-Lysergic acid disthylamide (LSD-25) given to 25 normal adults produced widespread temporary alteration in psychic functioning which resembles most the undeteriorated schizophrenic reaction type.

Insight and detachment are sufficiently preserved to allow recognition of the split between thinking and feeling as reality control becomes disturbed.

Rorschach tests completed in 13 cases allowed a fairly good prediction of a psychotic-like change from the control to the drug test, though the type of model psychosis could not be reliably anticipated.

Paranoid-like reaction (14 cases) showed a better correlation with the occurrence of complex synesthesiae, especially when the cross influence involved the examiner's voice and thoughts, on the one hand, and the subject's thoughts and bodily sensations, on the other.

Theories aiming at elucidating the working mechanism of this drug point toward enzyme inhibition, on the biochemical side, and predominant vulnerability of the temporal lobe-diencephalic circuits, on the neurophysiological side.

450 N. Bedford Dr.

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# Model Psychoses Induced by LSD-25 in Normals

## II. Rorschach Test Findings

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In a previous article[1] the widespread changes in psychic function induced by *d*-lysergic acid diethylamide (LSD-25) in 25 normal subjects were described in detail, with special attention to the emotional reaction of the subject to such disturbances in perception as may derange his ability to test reality. The available literature was reviewed, and theories aimed at explaining the working mechanism of this drug were commented upon. In the course of this study it was found that 14 of the 25 subjects developed feelings of persecution. Since this particular delusional trend is easily recognized, special reference was made to the sequential arrangement of those perceptual anomalies which gradually appeared to promote paranoid thinking.

When dealing with an acute exogenous toxic psychotic-like reaction, the dissolution of the familiar frames of reference against which reality is ordinarily tested immediately raises the important question whether or not a trend that progresses toward a psychotic breakdown depends on pathophysiological or psychopathological factors. It was felt that one possible answer might be obtained by examining some dimensions of the Rorschach personality projection test.

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In the light of some of the behavior results obtained with LSD-25, it seemed that it might be profitable to explore two important questions with the Rorschach test.

The first question which the test data would be called upon to answer was whether it is possible to predict, from a subject's personality make-up, what degree of disorganization, if any, will result from administration of the drug to a nonpsychiatric subject, and what kinds of behavior mechanisms would be rallied to help keep the ego organization intact. Thus, one might ask: "Is one able, from an assessment of X's strengths and weaknesses—his conflicts and defenses—as measured by his Rorschach performance, to state with any degree of confidence whether a Rorschach test administered at the height of the LSD reaction will reflect some ego distintegration, and, if so, how much and what features may be expected to characterize it?"

The second question, somewhat related to the first, might be posed as follows: "Will any psychopathological changes resulting from ingestion of the drug follow a uniform pattern, so that the resulting reaction is predictable in every case, regardless of the character structure of the subject, or are ego fractures likely to occur along the preexisting cracks of the personality, so that the reaction yields a caricature or distortion in keeping with the premorbid (normal) personality?"

Apart from these two questions, it seemed appropriate to analyze other aspects of the obtained data, in order to compare them with previous studies in the field. To this end, breakdown of the data along various dimensions was accomplished.

Though all 25 subjects had their Rorschach test while under the drug effect, the results for 12 had to be discarded for technical

reasons. In four instances the subjects were not available for the control test, and in eight the clinical LSD state had such a disruptive effect on the tests as to invalidate them.

The Rorschach test was twice administered to the remaining 13—once during the height of the LSD reaction, and a second time several weeks later, when the subject was in a lucid (normal) state. These represent the drug (or experimental) and nondrug (or control) conditions, respectively, of the study. Thus, each subject in the study served as his own control. Administration of the nondrug Rorschach test after the drug Rorschach test, rather than before, was designed to minimize the memory factor in order to obtain the greatest possible differences between the two records. These records were then evaluated along a number of dimensions, which are elaborated below. Apart from a quantification of the number of responses per record for each subject, no quantitative analysis (in terms of content, location, or determinants) of the data was made, owing to certain technical difficulties encountered in the course of the investigation. However, qualitative assessment has permitted analyses, which are herein summarized. Qualitative assessment was made by two separate ratings of each protocol—first along specific dimensions, and then of the record as a whole. Although the size of the sample is not large enough for adequate statistical treatment, efforts to quantify the qualitative ratings were undertaken in order to provide some minimal objectification of the judgments. These efforts have yielded results that are suggestive of some trends which a larger sample may possibly confirm at a statistically significant level.

Table 1 indicates the number of responses which each of the 13 subjects gave on both the drug and the control Rorschach tests. It also indicates the direction and extent of change from the control to the LSD record. Further, it lists the evaluations made of the LSD record in terms of whether the quality of the responses appeared sufficiently pathological to warrant the label "psychotic" on two separate appraisals.

Examination of the tabular data reveals that, as a group, there was greater variability in either direction—increase or decrease in total number of responses under drug—for those records judged "psychotic" than for those labeled "nonpsychotic," although this factor was not used as one of the criteria in making the judgments. It will be seen, too, that in all but 2 of the 13 drug Rorschach tests a drop occurred in the total number of responses. This finding is at variance with that reported by Stoll,[2] who recorded an increase in number of responses. The decrease found in the present study may be explained on the basis of restriction in ego function. That is to say, some of the possible effects of the drug include a reduction in general alertness, partial loss of ability to perceive accurately and integrate adequately environmental stimuli, and lessened drive and motivation to give Rorschach responses. In the two cases where there was a rise in total number of responses under LSD, the form level was appreciably lowered, there being poorer conformity of concept to blot area and poorer specification of the percept. The rise in number of responses might conceivably be accounted for by an apparent flooding of consciousness with uncontrolled ideation, which lowered the selective capacity of the subject in reporting percepts, re-

TABLE 1.—*Change in Number of Rorschach Responses Under the Drug*

| Subject | Control | Drug | Increase or Decrease in No. of Responses | "Nonpsychotic" or "Psychotic" Record |
|---|---|---|---|---|
| 1 | 48 | 59 | +11 | P |
| 2 | 24 | 15 | −9 | N |
| 3 | 58 | 47 | −11 | N |
| 4 | 48 | 68 | +20 | P |
| 5 | 67 | 37 | −30 | P |
| 6 | 35 | 33 | −2 | N |
| 7 | 37 | 36 | −1 | Marginal |
| 8 | 69 | 29 | −40 | P |
| 9 | 65 | 46 | −19 | N |
| 10 | 41 | 33 | −8 | N |
| 11 | 110 | 102 | −8 | P |
| 12 | 83 | 73 | −10 | P |
| 13 | 140 | 99 | −41 | P |

sulting in a flow of responses, which, however, were of inferior quality.

Table 2 presents a comparison of the number of Rorschach responses for both the drug and the nondrug conditions, broken down into two groups: those drug records judged "psychotic" and those judged "nonpsychotic"; one of the cases on which it was too difficult to make a decision is omitted in the tabulation. A perusal of Table 2 will show that, in the control condition, the mean number of responses for the "psychotic" group is 80.7, while under the drug this falls to 66.7. Inasmuch as the mean may not, because of the greater variability among the "psychotic" group, give an accurate picture of the results, the very high scores being misleading by imparting to the mean a spuriously high elevation, the median was calculated for each group. With this more conservative computational method, the medians for this category were 68 and 69 for the drug and control conditions, respectively. Although this appears to constitute no real drop, the results are affected by the 2 cases which went contrary to the other 11. On the basis of these data, two noteworthy trends are suggested: (*a*) Along with the already noted greater variability, the group labeled "psychotic" tended to have a greater fall in total number of responses from control to drug condition (apart from Subjects 1 and 4) than the group labeled "nonpsychotic." There is, of course, some overlap, but this appears to be true as a group. If confirmation of this trend is obtained in investigations using larger samples, the probability level is raised that such a fall—and, even more, a wide change in number of responses—may constitute a reliable sign of severe disturbance under drug. (*b*) Those persons giving a very high number of responses in the control condition tended subsequently to be labeled "psychotic." Put in another way, the greater the number of responses elicited in the control Rorschach record, the greater the likelihood of a psychotic-like reaction under drugs. As in the trend (*a*), described above, the cases of overlap introduce the risk of false negatives and false positives, and statistically significant differences have yet to be established.

TABLE 2.—*Total Number of Rorschach Responses for "Psychotic" and "Nonpsychotic" Groups Under Both Drug and Nondrug Conditions*

| | Control | | Drug | |
|---|---|---|---|---|
| | N | P | N | P |
| | 24 | 48 | 15 | 59 |
| | 58 | 48 | 47 | 68 |
| | 35 | 67 | 33 | 37 |
| | 65 | 60 | 46 | 29 |
| | 41 | 110 | 33 | 102 |
| | .. | 83 | .. | 73 |
| | .. | 140 | .. | 90 |
| Mean | 44.6 | 80.7 | 34.8 | 66.7 |
| Median | 41.0 | 69.0 | 33.0 | 68.0 |

The judgments—"psychotic" and "nonpsychotic"—were made on the basis of an over-all evaluation of the records. That is, qualitative psychotic indices were employed, such as those typically found in the records of patients diagnosed as psychotic. In addition, ratings were made along various dimensions, as previously mentioned. These dimensions included (*a*) level of anxiety; (*b*) amount and quality of destructiveness and hostility in content; (*c*) inferred attitudes toward, apparent preoccupation with, and general handling of, sexuality *; (*d*) "good-

* In making judgments on this dimension, the general level of apparent sexual adjustment was considered. Included were (1) ability of the subject readily to see appropriate sexual percepts in the "usual" blot areas, (2) a relaxed, undefensive attitude about giving such responses, and (3) ability to give reasonably good alternate concepts pointing to satisfactory integration. Higher (i. e., "pathological") ratings were assigned where subjects (1) avoided the so-called sexual areas in the blots, and could not respond adequately even when pressed; (2) tended to fuse or confuse male and female figures or sex organs; (3) gave disturbed (i. e., violent, explosive, or manifestly anxious) responses to the "sexual" blot areas; (4) made comments about sex or the corresponding blot areas reflecting emotional discomfort or distress; (5) registered a noticeable decline in form level in discussing either sexual topics or the "sex" areas in the ink blots; (6) gave bizarre, confused, homosexual-type, infantile, or other unusual responses to the blot areas, or (7) responded with a relatively high number of sexual responses, suggestive of preoccupation or overconcern.

ness" or "poorness" of the subject's object relations, and (*e*) a general rating of emotional maturity. Judgments for this last category were based partly on the foregoing dimensions, partly on the kinds of percepts elaborated by the subject, partly on the style of verbalization, and partly on subtle qualitative features of the record, which even highly experienced Rorschach workers find difficulty in identifying specifically. Ratings along these dimensions were, of course, inferential. Each record was rated twice, four to six weeks apart, on a scale of 1 to 4. On this scale, the ratings 1 and 2 represented good and fair adjustment, respectively; ratings of 3 and 4, similarly, represented moderate or severe maladjustment in the area.

on each of both Rorschach records for each subject. Inspection of Table 3 discloses that for every subject in virtually every category there is either stability or a rise (worsening of adjustment) in the rating from control to drug. The sole exception is in the area of sexuality, where two subjects each showed a drop of 0.3 in the rating from the nondrug to the LSD record. However, in both these cases, the ratings on the control Rorschach were higher than 3.5, so that the relative decreases were not significant, and, being inordinately high to begin with, reflected an unsatisfactory level of adjustment in this area.

In an effort to ascertain which factors were most closely associated with schizo-

TABLE 3.—*Mean* Rorschach Ratings Based upon Qualitative Appraisal of Entire Record*

| Subjects | Anxiety | | Hostility | | Sexuality | | Object Relations | | Emotional Maturity | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C† | D† | C | D | C | D | C | D | C | D |
| 1. | 2.0 | 3.0 | 2.5 | 2.0 | 3.0 | 3.0 | 2.0 | 2.0 | 2.0 | 3.0 |
| 2. | 3.0 | 2.5 | 2.5 | 2.5 | 2.0 | 2.5 | 2.5 | 2.5 | 2.0 | 3.0 |
| 3. | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| 4. | 3.0 | 4.0 | 2.5 | 4.0 | 3.0 | 3.2 | 3.0 | 3.5 | 2.7 | 3.7 |
| 5. | 3.0 | 3.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.3 |
| 6. | 2.0 | 2.5 | 1.5 | 2.5 | 2.5 | 2.7 | 2.0 | 2.7 | 2.0 | 3.0 |
| 7. | 2.0 | 3.0 | 2.0 | 3.5 | 2.5 | 3.5 | 1.7 | 3.2 | 2.0 | 3.2 |
| 8. | 2.5 | 4.0 | 2.5 | 3.5 | 3.7 | 3.4 | 2.7 | 3.7 | 3.0 | 3.8 |
| 9. | 2.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.5 | 3.0 | 2.5 | 3.0 |
| 10. | 3.0 | 3.5 | 3.0 | 3.0 | 3.0 | 3.8 | 3.0 | 3.0 | 3.0 | 3.0 |
| 11. | 3.0 | 4.0 | 3.5 | 3.5 | 3.8 | 3.5 | 3.0 | 3.8 | 3.0 | 4.0 |
| 12. | 2.0 | 4.0 | 1.5 | 3.5 | 1.7 | 3.0 | 2.0 | 3.0 | 2.0 | 3.7 |
| 13. | 3.0 | 4.0 | 3.0 | 3.5 | 4.0 | 4.0 | 2.8 | 3.8 | 3.5 | 4.0 |

* The mean represents an averaging of two separate ratings in each category, on a scale of 1 to 4.
† C = control Rorschach ratings; D, drug Rorschach ratings.

In 63% of the cases, or in better than 6 out of 10, there was perfect correspondence between the ratings. In the remaining 37%, discrepancies among the ratings on the same factor seldom varied more than 0.5, and never more than 1.0. In these cases of noncorrespondence, the ratings were averaged and a decimal value obtained.† These ratings are shown in Table 3, which lists five dimensions or factors separately evaluated twice

† For example, a rating of 3.0 on the first evaluation and one of 2.0 on the second would yield a mean rating of 2.5. Since it was not always possible to make the discrimination in terms of whole numbers, many of the ratings were 1.5, 2.5, or 3.5. The averaging of these decimals is what accounts for ratings like 1.7, 3.8, etc.

phreniform reactions under drug, as measured by a Rorschach record judged "psychotic," a further analysis of the data was undertaken. This was done in the following way: For all 13 records in each of the two conditions (drug and nondrug), a mean rating was computed for each of the five factors. Then a mean rating was computed once more for each of the five factors, but this time separately for the two groups ("psychotic" and "nonpsychotic"). These data, compiled in Table 4, point to the following trends: (*a*) Anxiety, which in the nondrug condition, did not differ in level between the "psychotics" and the "nonpsychotics," rose under LSD for both groups.

This rise was only slight in the case of the latter, but more perceptible (a 300% greater rise) for the former. (*b*) These results are virtually duplicated under the hostility, object relations, and emotional maturity factors. (*c*) These subjects who, in the control condition, showed the greatest amount of sexual preoccupation or disturbance tended to be judged "psychotic" under the drug. Yet this was only one of the elements considered in the over-all evaluations. In other words, the best indication of who will give a psychotic-like Rorschach response under LSD lies in the amount of difficulty or conflict in the sexual sphere as manifested in the nondrug record. Perhaps this needs to be stated more explicitly. Of the seven subjects who showed a "psychotic" reaction on the Rorschach response under LSD, all but one had ratings of 3.0 or more on the sexuality dimension. There was one false-negative result, Subject 7 having a rating of only 1.7. Of the five subjects judged "nonpsychotic" on their drug Rorschach records, none had ratings of more than 3.0. This suggests that with more refined measuring techniques these two groups might be more readily distinguished by this sign.‡

A sixth category—depression and elation—was originally employed in the rating but was omitted in the tabular data presented, for two main reasons—first, because no changes seemed to occur from drug to nondrug condition for the depressive factor, and, second, because little variability was found in the dysphoric elements from one subject to another. This raised the question as to whether, with the population under study, this factor was being tapped or could be elicited. Only two records could be characterized as euphoric, although several others showed the rambling speech, increased productivity, and poorly controlled ideation approximating flight of ideas. Such signs were not clear-cut and did not occur with sufficient frequency in association with other classic signs of hypomania in the Rorschach findings (e. g., oral-biting content, use of C′). In this sense, the data are not very supportive of reports such as that by Gastaut and associates,[3] which have declared that behavioral reactions under LSD more closely approached those of manic-depressive psychosis and anxiety than of schizophenia.

The Rorschach test findings, then, tend to show that there are, potentially, indices of prediction for psychotic-like reactions under LSD, although the presently obtained ones would appear to require considerable refinement. The two "best" kinds of predictors seems to be (*a*) excessive productivity and (*b*) pronounced sexual disturbance in the control Rorschach record.

Comparison of the drug Rorschach results with the clinically observable LSD effect showed good agreement in 11 out of 13. In one case in which the drug Rorschach record was considered "psychotic" and which could be so predicted on the basis of the abovementioned two most reliable indices, the clinical picture was completely devoid of any psychotic feature. In another case, the drug Rorschach record was labeled nonpsychotic and the control test predicted this by virtue of the absence of excessive productivity and the low (well-adjusted) "sexuality" score. The Rorschach profile contained

TABLE 4.—*Changes in Mean Rorschach Ratings Under Drugs*

| | Anxiety | | | Hostility | | | Sexuality | | | Object Relations | | | Emotional Maturity | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | M* | N | P | M* | N | P | M* | N | P | M* | N | P | M* |
| C | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.7 | 3.2 | 2.9 | 2.6 | 2.6 | 2.5 | 2.5 | 2.7 | 2.6 |
| D | 2.9 | 3.8 | 3.4 | 2.8 | 3.2 | 3.1 | 3.0 | 3.3 | 3.2 | 2.8 | 3.3 | 3.2 | 2.9 | 3.6 | 3.3 |
| D-C | 0.3 | 1.2 | 0.8 | 0.2 | 0.6 | 0.5 | 0.3 | 0.1 | 0.3 | 0.2 | 0.7 | 0.6 | 0.4 | 0.9 | 0.7 |

* All 13 subjects were used in obtaining the mean; only 12 of the cases are included in the other headings of the Table—"nonpsychotic" or "psychotic," the 13th having been rated as marginal or borderline.

‡ It is, of course, possible that the discernibly higher ratings in this category may not stand up well to finer metric tools, but may be a function of cultural attitudes toward sex that everyone in the population shares. It is also possible that Rorschach workers, in general, may be overly sensitized to sexual problems.

no indications of personality defects or defenses thereto that would have foreshadowed a paranoid schizophrenic reaction. Yet, this was the subject (A) who started out by having visual hallucinations of Mexican peons dancing on the wall, which was followed by "breathing" walls, the rate of which depended on the examiner's voice. When random noises in the background further influenced the wall breathing, she felt markedly persecuted, and her resultant negativism persisted throughout the experiment.

The character of the sample under study may be responsible for another type of finding in this research. Traditionally, psychoanalytic theory has associated obsessive-compulsive personalities with a talent for paranoid ideation or tendencies. In the evaluation of the Rorschach records taken under the control condition, it was attempted to note the kind of defenses which the subject employed, and to what degree. For virtually all, it was obvious that no one mode of defense was being exclusively utilized, although some showed a predominantly hysterical orientation, while the greater part could be called predominantly obsessive-compulsive. However, mixed defenses were the rule. As a result, it was not surprising to find a paranoid potential in all of the subjects, although no predictable pattern emerged. That is, such characteristics as suspiciousness and propensities for projection were not found to be present more frequently or in greater amounts in those subjects who under control conditions exhibited a higher degree of obsessive-compulsiveness than those exhibiting only a moderate degree of obsessive-compulsiveness. In fact, it was found that responses such as "eyes," "a big figure coming straight at me," and similar expressions occurred in some of the relatively benign ("nonpsychotic") records taken under LSD.

Although, as the tabular data show, the drug records fairly uniformly reflect a worsening of the personality picture for all of the 13 subjects, some interesting features may deserve mention. In the case of three of the subjects, a comparison of the Rorschach content—drug against control—revealed that the content of the control record appeared more pathological than that of the drug record. In these cases, although the verbalizations under LSD were somewhat chaotic and, therefore, easily distinguishable from the control protocol, the drug Rorschach content was frequently less frankly sexual, destructive, or self-referential than the control. In spite of this paradox, all three of these subjects had a very pronounced psychotic reaction with a paranoid trend.

In all of the cases in which psychotic-like reactions were observed in the drug Rorschach record, there was some evidence of bizarreness, poor or peculiar specification, negativism, paranoid tendencies, or similar kinds of pathological features. However, only some of these were clearly pathognomonic for schizophrenia; other reactions were less readily classifiable. This is in essential agreement with the impressions of DeShon, Rinkel, and Solomon,[4] who, among their five subjects, found a variety of reactions—some clearly schizophrenic-like, some less so, and one "borderline record which could not be regarded as characteristic of any psychiatric syndrome."

The similarity in much of the content of the "pre-" and "postdrug" records rendered it relatively easy to match the Rorschach records for each subject. Despite the obtained differences, there was a core of identifiable similarity that was more prominent, thus facilitating the matching task. And, apart from the additions or omissions of specific responses, only modifications of the perceptions (with only negligible alterations in specification) can be said to have occurred, rather than any basic changes in the personality picture.

In view of the psychoanalytical theory of paranoid schizophrenia, according to which persons with this psychosis show confusion in psychosexual identification and resort to psychosis in order to keep their repressed homosexuality from breaking into consciousness, it was felt that the "sexual-adjustment" factor (which took such disturbances into

account) might be well worth matching against the clinical picture. Of the 5 subjects (out of the 13) who became frankly paranoid, the scores were as follows (the first figure giving the control, the second the drug, Rorschach data): 3-3, 2.5-2.25, 3-3.2, 3.8-3.5, and 4-4. According to this rating, although with one exception all of them scored poorly on the control, the "sexuality" factor was not further disturbed in the LSD state. The nonparanoid psychotic reaction cases scored 3-3, 3.7-3.4, and 1.7-3. It is interesting to compare these findings with those of Zeichner,[5] who, by doing comparative Rorschach tests, found that nonparanoid schizophrenic patients exhibit more confusion in psychosexual identification than do paranoids, though the paranoid patients (males) more frequently show identification with females than other forms of schizophrenics.

When the hostility factor among the paranoid cases is examined, the score is even less suggestive of the clinical state (2.5-2, 2.5-2.5, 2.5-4, 3.5-3.5, 3-3.5). The fact that the sexuality and hostility factors undergo so little change from the control to the drug situation might be an expression of the artificial nature of the schizophrenic state induced by LSD, leaving intact the core of that part of psychic organization which is responsible for insight. In this respect, therefore, the acute exogenous reaction induced by LSD differs from toxic psychoses occurring clinically. In the LSD state the subject always knows "what the score is."

In summary, then, the Rorschach tests indicate that there is much to suggest which normal record will become psychotic and considerably less to predict what particular form the psychosis will assume.

On the other hand, in the 14 cases in which the clinically observable reaction took an easily identifiable paranoid direction, the trend showed a much better correlation with the occurrence of gradually more complex and threatening synesthesiae.[1] In nonparanoid psychotic states, synesthesiae, when present, remained simple, and the emotional reaction thereto was devoid of apprehension or, for that matter, of affect of any noteworthy intensity. The paranoid reaction at times was coupled with aggression, less frequently with depression.

We believe that anyone who follows the results of these tests objectively will come to the conclusion that the question whether the paranoid reaction to interference with reality testing ability brought about by strange perceptual anomalies is a result of pathophysiological or psychopathological mechanisms remains open. There is much in favor of either alternative, and there is even greater likelihood that there are no alternatives but, rather, that we are witnessing here a combined process.

SUMMARY

Of 25 Rorschach studies obtained in the LSD and in the lucid state, 13 were of sufficiently good quality to permit comparison.

The number of responses and the factor of "sexuality" were the most reliable indicators to predict a psychotic reaction.

The Rorschach test furnishes considerably less precision with which the type of psychotic reaction can be predicted.

In the paranoid reactions alone, the occurrence of complex synesthesiae appeared to have more of a predictive value than the Rorschach test results.

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# Environmental Change and Age of Onset of Psychosis in Elderly Patients

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## A. INTRODUCTION

The traditional classification of mental disease among elderly people separates senile psychosis and psychosis with cerebral arteriosclerosis from the psychogenic group of illnesses. This separation recognizes the roles of neuronal degeneration and cerebral vascular damage in the etiology of these disorders. The trend of modern opinion, however, is toward the belief that even among the apparently organic group of psychoses, the degree of mental disability is not entirely dependent upon the degree of organic brain damage but is influenced by social and psychological factors as well.* It is suspected, for example, that environmental changes of an uprooting or isolating nature may have the undesirable effect of precipitating or accelerating the onset of psychotic behavior in the elderly person.

If this is so, it should be possible to demonstrate, among elderly mental patients experiencing an environmental change before the onset of their psychosis, a correlation between age at change and age at onset. The investigation of such a relationship forms the subject of the present paper.

## B. METHOD

A more detailed statistical description of the method employed is given in Appendix I. The general principles will be described here.

An analysis was made of patients admitted at ages 65 and over to the Ontario Hospitals at London and St. Thomas between the years 1950 and 1952. Only patients for whom age of onset had been provided by the informant were included.

Those patients who had undergone an environmental change after age 40 but before the onset of their psychosis were separated from the rest of the group. Three types of environmental change were considered: retirement (for men only), a change in the size of area of residence, and a change in home situation or living arrangements. Exact definitions of the last two are given in Appendix II. Taking all possible combinations of these changes led to the establishment of seven mutually exclusive categories of male patients and three such categories of female patients.

Superficially, the simplest method of analysis would appear to be the calculation of a correlation coefficient between age at change and age at onset for each category of patients. However, this would be unsatisfactory because by definition the patients to be studied had their onsets after their environmental change; therefore some correlation would inevitably exist between the two ages. For this reason, a different statistical approach had to be taken. For each patient an expected age of onset was determined on the basis of the null hypothesis that no relationship existed between his environmental change and the onset of his psychosis. The method for calculating these expected ages is described in detail in Appendix I. The difference between expected and observed onset was then recorded for each patient. The average of these individual differences was determined for each category of patients. If for any category the observed ages of onset were systematically earlier than the ages expected, the average difference (expected minus observed age) would be significantly greater than

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zero. This would indicate that the age at which manifest psychotic symptoms began was influenced by the occurrence of the particular environmental change being considered.

This analysis was carried out first for all diagnoses combined. It was then followed by a separate analysis for each of three diagnostic groups: (1) senile psychosis; (2) psychosis with cerebral arteriosclerosis (C. A. S.), and (3) other diagnoses—affective disorders, schizophrenia, psychoneuroses, alcoholic psychosis, etc.

### C. RESULTS

The numerical results are given in Tables 1 and 2, where for each diagnostic group and category of environmental change, the average difference between expected and observed ages of onset is shown. Beneath each average the number of patients in the group is indicated.

1. All Diagnoses Combined

(*a*) Males

The age of onset was significantly related to the age at environmental change for males in two of the seven categories, those with retirement plus area change and those with retirement plus area plus home-situation change.

When the group with retirement plus area change was further subdivided according to whether the two changes were coincident or occurred separately, the mean differences between expected and observed onset

TABLE 1.—*Mean Values for Expected Minus Observed Age Onset by Sex, Diagnosis, and Category of Change—Men*

| Category of Change | All Diagnoses | C. A. S.* | Senile | Other |
|---|---|---|---|---|
| Retirement only | | | | |
| Average | +1.1 | +1.0 | +0.5 | +3.3 |
| No. of patients | 57 | 25 | 24 | 8 |
| Area only | | | | |
| Average | +3.6 | +0.8 | +5.9 | +4.9 |
| No. of patients | 8 | 3 | 2 | 3 |
| Home situation only | | | | |
| Average | +2.5 | −1.8 | +9.8 | +4.7 |
| No. of patients | 7 | 4 | 2 | 1 |
| Retirement+area | | | | |
| Average | +2.9† | +1.5 | +4.1 | +4.6 |
| No. of patients | 21 | 10 | 9 | 2 |
| Retirement+home situation | | | | |
| Average | +0.1 | −0.3 | +0.1 | +1.7 |
| No. of patients | 27 | 14 | 9 | 4 |
| Area+home situation | | | | |
| Average | +6.8 | +6.6 | +7.7 | +6.6 |
| No. of patients | 5 | 2 | 1 | 2 |
| Retirement+area+home situation | | | | |
| Average | +2.7* | +2.2 | +3.8 | ..... |
| No. of patients | 16 | 11 | 5 | 0 |

* Cerebral arteriosclerosis.
† Significant, $P < 0.02$.

TABLE 2.—*Mean Values for Expected Minus Observed Age Onset by Sex, Diagnosis, and Category of Change—Women*

| Category of Change | All Diagnoses | C. A. S.* | Senile | Other |
|---|---|---|---|---|
| Area only | | | | |
| Average | −0.2 | −0.9 | +1.2 | −9.6 |
| No. of patients | 23 | 10 | 12 | 1 |
| Home situation only | | | | |
| Average | +1.2 | +1.1 | +0.2 | +3.0 |
| No. of patients | 58 | 18 | 28 | 12 |
| Area+home situation | | | | |
| Average | +3.1† | +4.0 | +3.6 | +0.9 |
| No. of patients | 28 | 10 | 11 | 7 |

* Cerebral arteriosclerosis.
† Significant, $P < 0.001$.

were +3.6 years and +1.7 years, respectively. Only the former was significantly greater than zero.

In the second category, two of the three changes occurred at the same time in 14 out of the 16 patients.

(*b*) Females

A significant relationship between age at environmental change and age at onset was found for patients with area plus home-situation change. Although the difference was significant whether the changes occurred together or separately, the difference was greater where the two changes were coincident (+3.4 years compared with +2.7 years).

2. By Diagnosis

Breakdown by diagnosis led to groups with very small numbers. Therefore although mean values were calculated for all groups, assessment of statistical significance was not attempted. The main points to emerge from this analysis were the following:

(*a*) Males

(1) Retirement Only: The group with other diagnoses had a mean difference between expected and observed onset of +3.33 years.

(2) Retirement plus Area Change: A positive difference occurred in each group but was greater for the "senile" and "other" groups. (The latter, however, consisted of only two patients.)

(3) Retirement plus Area plus Home-Situation Change: The senile and C. A. S. groups both had patients in this category, and in each case the difference between expected and observed onset was positive.

(*b*) Females

(1) Home-Situation Change Only: A mean difference of +3.02 years was found for the 12 patients in the "other" group.

(2) Area plus Home-Situation Change: The difference was positive in all groups but was much greater in the C. A. S. and senile patients.

No attempt was made in the analysis by diagnosis to subdivide further the multiple environmental changes according to whether they occurred separately or together. The size of the sample also precluded separate consideration of the effects of different kinds of area and home-situation change. However, the commonest type of area change was a move from a small to a larger community, and the commonest type of change in home situation was from living with the spouse to living with children, with relatives, or alone. In other words, the home-situation change was most frequently the result of widowhood.

### D. COMMENT

The results suggest that among males the most important of the three types of change is that of an area change, because significant "earlying" of onset occurred when this change was combined either with retirement or with both retirement and home-situation change, whereas neither of the latter changes when they occurred alone showed a significant effect. Lack of significance for area change only and area plus home-situation change may be attributed partly to the small sample sizes, since the mean differences between expected and observed age of onset were both large. The nonsignificant effect of retirement alone is surprising, for it is commonly believed that cessation of regular work is one of the outstanding causes of a decline in physical and mental capacity among elderly men.[7]

Among females it was clear that "earlying" of psychosis was specifically associated with the combined change in area of residence and in home situation.

In both sexes, two environmental changes occurring together had a greater effect than the same two changes occurring separately.

Of considerable interest is the difference between the sexes in the importance of

change in area and home situation. It appears that the elderly man is more affected by a move to a different type of community than by a domestic dislocation, while the woman is less vulnerable to a change in community unless it is accompanied by a domestic change as well. These observations are very much in keeping with the generally accepted dictum that a man's life is centered more in the community and a woman's in the home.

Diagnostic breakdown, although not yielding statistically definitive results, indicated that the relationship was not confined to any particular diagnostic group. This is particularly important, for it means that the influence of environmental change was obvious in both of the organic psychoses. Williams and his associates [6] were of the opinion that environmental stress was more commonly an antecedent of senile than of arteriosclerotic psychosis.

Two possible artefacts must be considered. A closeness between age of environmental change and age of onset could be merely a result of the recognition of preexisting psychosis in the changed environment. For example, a psychotic woman who goes to live with her children after the death of her spouse is recognized by them as psychotic for the first time. Or, conversely, an environmental change might be undertaken by a patient because of his psychosis. If either of these were the real explanation of the results, one would expect that the "earlying" effect would be obvious only in patients where the interval between environmental change and onset was extremely short. This was investigated, and it was found that among men with retirement plus area plus home-situation change and among women with area plus home-situation change the differences between observed and expected onset were still positive even when the interval between change and onset was at least three years. Thus it seems unlikely that the results obtained can be explained in these ways.

It must be emphasized that the relationships revealed by this analysis apply specifically to those patients selected for study because they had an environmental change before their psychosis was manifest. Since only about one-half of the total elderly patient group was in this category (as may be seen from the figures in Appendix I), it is obviously incorrect to interpret the results as indicating that environmental change is inevitably a precipitating factor in the psychoses of the upper age groups. All that has been demonstrated is that when such a change does occur it appears to have some influence upon the time of onset of psychosis.

## SUMMARY

To explore the possibility that environmental change can accelerate the onset of the psychoses of old age, an examination has been made of the degree of statistical association existing between the age of onset of these psychoses and the age of occurrence of three kinds of environmental change.

The analysis was based upon 516 mental hospital patients aged 65 years and over. Compared with the average age of onset for the group as a whole were those for 245 patients among whom retirement, a move to an area of a different population size, or a change in living arrangement had occurred alone or in combination after age 40 but before onset of psychoses.

Patients characterized by certain combinations of the three changes studied had an earlier average age of onset than expected. This was particularly true of those males who had experienced a change in area of residence and of those females having a history of change both in area of residence and in living arrangement.

In general, degrees of association were consistent among the three diagnostic groups considered: senile psychosis, cerebral arteriosclerosis, and a mixed group of affective, schizophrenic, and other disorders.

While far from conclusive, it is suggested that these observations are at least compatible with the initiating hypothesis of the study.

## APPENDIX I

### Statistical Methods

Analysis was based upon the following rationale: The average age of onset among patients comprising our sample is, by statistical definition, the value from which positive and negative deviations of the component ages of onset yield an algebraic total of zero. The component ages of onset of a subsample should also be distributed above and below the average for the total sample in such a way that deviations approximate zero (within the limits of sampling error), unless the subsample is characterized by a variable, foreign to the rest of the sample, which influences age of onset.

Under the latter circumstances, if the variable tends to delay onset, components of the subsample should be overrepresented above the average age of onset in the sample taken as a whole. Conversely, if the variable tends to accelerate onset, overrepresentation below the average should occur.

These effects can be measured by computing the average positive or negative deviation for the subsample and by then determining, on the basis of its standard deviation, whether or not this average differs significantly from zero.

This, in essence, is what was done, the subsamples being defined by kinds of environmental change.

The following calculations were therefore made:

1. From the whole group of patients, 243 males and 273 females, tables of cumulative age of onset were constructed so that the mean age of onset for all patients with onset at or beyond any specified age could be determined. This was done for male and female patients separately, within each of the three diagnostic groups, senile, C. A. S., and other.
2. The patients with environmental changes occurring at a known age and before onset of psychosis, 141 males and 104 females, were then placed in the seven possible categories for males and three for females. Expected ages of onset were calculated in the following way. If a patient had an environmental change at age $x$, his expected age of onset was taken as the mean age of onset for all patients with the same diagnosis whose psychoses began at age $x+1$ or later. Where more than one environmental change had occurred, the patient's age at the time of the most recent change was used for determining the expected onset.
3. For each category of patients, the significance of the group's mean difference between expected and observed onset was assessed in terms of the critical ratio of the mean to its standard error, using the $t$ distribution.[8]

## APPENDIX II

### Definition of Environmental Changes Other Than Retirement

1. Area Change: A move to another municipality which involved a change in the size of the municipality. Five size categories were used:

(1) Farms
(2) Nonfarm rural areas, of under 1000 population
(3) Villages or towns, of 1-9000 population
(4) Small cities, of 10,000-29,000 population
(5) Larger cities, of 30,000 population or greater

2. Home-Situation Change: Any change in the living arrangements of the patient from one to another of the following categories:

(1) Living with parents
(2) Living with spouse (with or without children)
(3) Living with children
(4) Living with relatives
(5) Living with friends
(6) Living alone
(7) Living in an institution (mental hospitals excepted)

A change in the home situation from (1) to (2) was excluded, because in the rare instances in which it occurred after age 40 it represented nothing more than a late marriage.

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# Observations on Phantom-Limb Phenomena

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Loss of limb, in man, is often followed by an illusion—the conviction that the limb, or parts of it, continues to be present. Wier Mitchell [30] coined the term "phantom limb" to designate this phenomenon, but descriptions can be found for centuries before him.* The more recent literature has assumed forbidding proportions,† yet the phenomenon itself remains puzzling. Perhaps all attempts at explanation are premature until we know more about the phenomenon itself, for the great mass of studies tells us little about such simple questions as the incidence of phantom limbs after amputation, the relative frequency of different phantom sensations, or the changes in the illusion with time.

To answer these questions, one needs systematic surveys of groups of cases; most of the available accounts are based, instead, on particularly striking aspects found in selected instances. Thus, for obvious reasons, painful phantoms (first described by Paré in 1552) have been discussed at the expense of "natural" painless phantoms, which are actually much more frequent.‡

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Dr. Hans-Lukas Teuber suggested the problem and aided in the preparation of this report. This work is based on sections of a dissertation submitted in 1954 in partial fulfillment of the requirments for the Ph.D. degree in the Graduate School of Arts and Science, New York University. The work was supported in part by the Commonwealth Fund of New York, through their grant to the Psychophysiological Laboratory.

* References 15 and 31.

† References 4, 5, 11, 17, 29, 36, and 40.

‡ References 11, 17, 19, 25, 36 and 40.

A good deal of the literature on phantom limbs is concerned with theories about their origin. These theories are based on conjectures but are nevertheless useful in guiding one's observations. There are essentially three views on etiology: a peripheral view, a central view, and a third approach, combining the other two.

## THEORIES

*Peripheral Theory.*—This theory ascribes phantom limbs to sensations arising from nerve endings in the stump.§ Impulses are said to be triggered off by irritants, such as neuromata, mechanical defects, scar tissue, or anoxia. Sensations due to the propagated impulses are assigned to parts originally innervated. Thus the phantom is "projected" to those areas which had been supplied by the nerve trunk, even though the distal fibers were lost with the amputation.

Attempts at direct confirmation of the peripheral theory have been made by claiming that presence of neuromata or excessive scarring of the stump are associated with especially persistent and painful phantoms; by claiming beneficial effects of peripheral surgery, and by claiming that phantom sensations are readily influenced by stimulation of the stump or its nerves.

Evidence on all these points is far from convincing. The impression of association between neuroma and persistent phantom is based on unsystematic observations and is rejected by many neurosurgeons.‖ Similarly, there are few that accept without question the claims for beneficial effects on phantoms of corrective surgery on the stump, removal of neuroma, proximal cutting of sensory nerves, dorsal root sections, or blocking or

§ References 10 11, 23, and 34.

‖ References 9, 23, 27, 28, and 43.

removal of sympathetic nerves and ganglia (for example, Leriche [23] and Livingston [26]). The literature contains numerous references to persistence of phantoms following any one of these maneuvers or various combinations of them.¶ The situation is even less clear with regard to the claim that phantom sensation may be modified, transiently or permanently, by applying various stimuli to the stump, for example, percussion,# electrical stimulation,* or anesthesia by freezing † or procaine hydrochloride (Novocain).‡ Such experiments are important, but the evidence is scarce and contradictory.§ By itself, modifiability of phantom sensations through stimulation or anesthesia of stump or nerve trunks would not be sufficient proof for the peripheral origin of phantom sensations.

*Central Theory.*—This theory attributes characteristics of the phantom experience to processes in the central nervous system which are considered more or less independent of sensory impulses from peripheral stimulation. Support for this view is mostly indirect, deriving from failure to confirm the peripheral theory. The central theory appears in at least two forms, depending on whether persisting awareness of body parts is attributed to learning or innate organization.

In the earlier form of the central theory, emphasis was on learning; central processes which continue to "represent" a limb even after its loss are assumed to be acquired in an individual's development. The notion of such an acquired but persisting "body image" originated with Pick [33] and was elaborated by Head [16] and by Schilder, who believed that "the phantom . . . is the reactivation of a given perceptive pattern." ||

¶ References 4, 5, 9, 22, 27-30, and 43.

# References 5, 29, and 34.

* References 30 and 34.

† References 1, 33, and 37.

‡ References 28 and 40.

§ References 5, 29, and 40.

|| Reference 38, p. 67.

Support for such empiristic body image notions comes from various sources: the supposed lack of phantom sensations in cases of congenital absence of limbs, after amputation in young children, or, in adults, after prolonged anesthesia of the limb prior to its removal.[33] All of these claims need confirmation. Closely related is the idea that phantom sensations can be kept more "natural" and more vivid if soon after amputation the patient takes daily exercises in "willing" phantom movements ¶; such exercises are said to make a patient better able to use a mobile (cineplastic) prosthesis.[21] Finally, there is the claim that certain phantoms may be forever fixed in the particular posture assumed by the limb at the moment of injury # or that phantom sensations perpetuate what the patient felt in his limb at the time it was lost.* In addition, some observers record that a phantom experience might incorporate a ring or wristwatch worn before the amputation.[17] It is not known whether such reports are typical or rare. Frequent occurrence of such superadded features [17] in phantoms would not be expected on the basis of a nativistic theory.

According to the nativistic version of the central theory, phantom sensations should show considerable uniformity, since they reflect constant and generic features of central representation in sensory and motor systems. This representation is assumed to depend on structural rather than functional (acquired) patterns. Support for this notion can be derived from recent work by Teuber and co-workers [40] and myself,[14] which will be summarized below.

A general argument, advanced for any central theory, is the claim that phantom limbs are modified or disappear in the presence of certain cerebral lesions. Head reports a case in which a cerebral hemorrhage into the parietal lobe abolished a previously existing phantom limb on the opposite side of the body.[16] Various recent attempts to

¶ References 19 and 40.

# References 3 and 18.

* References 16 and 36.

alleviate painful phantom conditions by cerebral resections † could also give support to central theories, but the results of these procedures are not always satisfactory.‡ Even if they were, we could not accept them as proof of a central theory, since no proponent of peripheral factors denies that brain or cord lesions can interfere with reception of sensory impulses.

*Mixed Theory.*—This theory, which invokes both peripheral and central factors, has been introduced primarily to account for the fact that painful phantom or stump conditions are equally hard to control whether surgery is directed at peripheral or central structures. The main proponent of a combined action of peripheral and central factors is W. K. Livingston,[28] who assumes that peripheral irritation generates activity in internuncial centers of the spinal cord, initiating a reverberatory self-perpetuating circuit. This abnormal activity brings about changes in peripheral tissues and in central projections, activating perception of the absent limb.

Livingston's view has the virtue that it could account for success of methods directed at the periphery (for example, regional sympathectomies) in the early stages of a developing painful phantom and for the failure of such "peripheral" procedures (in contrast to cord or brain surgery) at a later stage, after abnormal central activity has become established. Here, again, we lack sufficient information on the natural history of phantoms, painful or painless, so that the merits of a mixed theory cannot be assessed.

## SURVEYS

Such information can be obtained only from systematic and quantitative studies. As we have noted, the number of such surveys is surprisingly limited. The earliest investigation of this sort is one by Katz,[19] undertaken soon after World War I. During World War II, Henderson and Smyth[17] gathered voluminous data on amputees in a prisoner-of-war camp, but their records were lost owing to war action, and their published conclusions had to be based on what they could recall. Their general findings, however, are in good agreement with the earlier work of Katz and with the two subsequent surveys, the one by Cronholm[5] and that of Teuber and co-workers.[40] The latter study, based on examination of 40 above-the-knee amputees, employed psychophysical methods for assessing the sensory status of the stump and provided detailed statistics on nature and course of phantom sensations. Since the bulk of their results is not generally available § and since our own study is primarily based on theirs, we are giving here some of their findings and conclusions.

1. Different parts of the lost limb are represented in the phantom to an unequal degree, with distal parts predominating over proximal parts; as a result, some phantoms have proximal "gaps." 2. Certain qualities of sensations (for example, "tingling") are much more frequently reported than others. 3. Illusions of motion in the phantom, where they do occur, are more frequently motions of adduction than of abduction. 4. Most phantoms "shrink" with time; where shrinkage is extensive, it follows a definite sequence, again with certain distal parts most persistent and proximal less; as a result, some phantoms become "telescoped" into the stump, while others remain extended (Katz ‖).

Teuber and co-workers [40] interpreted these observations as supporting a central theory of the origin of phantom sensations. They pointed out that the relative extent and vividness of phantom sensations conformed to the known relative extent of sensory representation in the C. N. S. (for example, large for toes, and small for thigh), and they emphasized the similarity between the quality of phantom sensations and of sensations evoked by electrical stimulation of sensory cortex.[32]

† References 7, 8, 12, 13, 24, 39, and 42.

‡ References 4, 22, and 26.

§ References 40 and 41.

‖ References 19 and 20.

Even stronger support for the role of central factors was derived by Teuber and co-workers from certain observations they made on the sensory status of the stump. They found "trigger-zones" on the stumps of some of their amputees; stimulation of these zones by light tapping or rubbing produced sensations of tingling which the amputees described as "spreading" distally into certain parts of their phantoms. Mapping the course of these spreading paresthesiae of tingling, they noted that the resulting maps failed to correspond to known distributions of peripheral nerves; in some instances, the pattern of distributions appeared to follow dermatomal arrangements for the lower limb.¶

Finally, these authors measured two-point discrimination, i. e., the minimum distance on the skin at which two points of a touch compass can be recognized as two. Such thresholds were obtained in two regions of the stump and in the homologous regions of the sound limb. In the normal limb, such thresholds vary systematically with distance from the trunk. They are smallest on the toes and large on the thighs, indicating that the more distal parts are capable of finer sensory discrimination. Distal parts also possess a denser distribution of sensory nerve endings than do proximal parts; it is therefore considered understandable, on peripheral grounds alone, that the distal parts should excel the proximal ones in sensitivity. Following amputation, however, sensitivity (two-point discrimination) in the area of the stump was found to surpass that in homologous regions of the sound limb.[41] It seemed as if some central reorganization had occurred which conferred on the stump some of the functions of the more distal portions of a normal limb.

In a previous study [14] I tested the generality of these observations by extending the work to upper-limb amputees. The range of sensory tests was likewise extended to include light-touch thresholds and point localization, in addition to two-point discrimination. Results showed that stump sensitivity in 24 arm amputees surpassed that of homologous parts of the normal arm for light touch, two-point discrimination, and point localization. The differences were large, and their statistical significance exceeded the 0.001 level of probability. Just as in the earlier studies,# there was no indication that the gain in sensitivity following amputation could be due to peripheral factors, such as folding of skin or change in nerve supply. Central factors were further suggested by the curious finding that stump sensitivity conformed to the type of phantom reported by the amputee. Those who had "telescoped" phantoms (i. e., phantoms in or near stump) showed a significantly higher gain in stump sensitivity (at least for point localization) than those whose phantoms had dimensions of a normal limb.[14] In the present investigation, a systematic survey was made of phantom phenomena in the group of arm amputees, with the purpose of considering whether these phenomena should be attributed to peripheral or central factors or to both.

## MATERIAL AND METHODS

*Subjects.*—The subjects were 24 men with unilateral above-elbow amputations; all were veterans of World War II, living in the New York area, and made available by the National Amputation Chapter 76.* The 24 subjects comprised 12 men with left and 12 with right amputation. All stumps measured at least 10 cm. in length, the average being 16.9 cm. Subjects were excluded if they had demonstrable injury to the central nervous system or history of concussion, prolonged unconsciousness, or major surgery. In all instances, loss of limb had occurred from 8 to 12 years prior to testing. The age of the 24 men ranged from 27 to 43 years, with a mean of 33, and their I.Q.'s (by an abbreviated Wechsler-Bellevue Adult Intelligence Scale) from 104 to 141, with a mean of 119. Of the 24 men, 18 wore a prosthesis; 7 wore a mechanical hook or glove, 9 wore a nonfunctional (cosmetic) glove, and 2 sometimes wore a functional and sometimes a cosmetic prosthesis.

¶ Reference 40, p. 27.

# References 40 and 41.

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TABLE 1.—*Ratings of Twenty-Four Amputees on Phantom Sensations*

| Vividness | No. | Per Cent | Duration | No. | Per Cent | Affective Tone | No. | Per Cent |
|---|---|---|---|---|---|---|---|---|
| Strong | 7 | 29.1 | All the time | 2 | 8.3 | Pleasant | 3 | 12.5 |
| Moderate | 9 | 37.5 | Most of the time | 9 | 37.5 | Unpleasant | 12 | 50.0 |
| Vague | 4 | 16.7 | Some of the time | 12 | 50.0 | Painful | 1 | 4.2 |
| Mixed | 4 | 16.7 | Seldom | 1 | 4.2 | None | 8 | 33.3 |
| Total | 24 | 100 | | 24 | 100 | | 24 | 100 |

After determination of sensory thresholds on stump and sound limb,[14] each amputee was given a structured interview designed to elicit characteristics of his phantom sensations. The interviews were held individually in an informal setting and lasted from 20 to 30 minutes. The term "phantom limb" was not used by the examiner unless it was introduced by the subject. At the end of the interview, each subject made a pencil drawing of his phantom limb.

## RESULTS

*Prevalence and Quality.*—Phantom sensations were reported by all 24 subjects. Two-thirds of the group described these sensations as "strong" or "moderate," and the remaining third called them "vague" or "variable." The majority experienced their phantom intermittently; only two said they felt it all the time, and only one said explicitly that he felt his phantom "seldom." Only one subject reported severe pain. All others characterized the affective tone of their phantom sensations as indifferent (8 subjects), moderately unpleasant (12 subjects), or pleasant (3 subjects). These reports are summarized in Table 1.

When the men were asked to describe the quality of their phantom sensations, two-thirds used the terms "tingling," "pins and needles," "as if asleep," "vibrating," or "electricity." Almost as frequent were expressions of feelings of tenseness in the phantom, or of "clenching," "clutching," "gripping" (14 subjects); in half of these, apparently, "tingling" and "clenching" sensations coexisted. Itching was reported by seven subjects, who felt it strongly enough to scratch a nonexisting palm or other phantom part. Reports of "throbbing" or "pulsating" sensations were next in frequency (five subjects); in all but one of these, tingling coexisted with throbbing. "Numbness" was reported by four subjects. Sensations of

TABLE 2.—*Descriptions of Phantom Sensations*

| Subject No. | Tingling | Tenseness | Itching | Throbbing | Numbness | Warmth | Natural | Pain |
|---|---|---|---|---|---|---|---|---|
| 1 | .. | .. | .. | .. | .. | .. | • | .. |
| 2 | • | .. | .. | .. | .. | .. | .. | .. |
| 3 | • | .. | • | .. | • | • | .. | .. |
| 4 | • | • | .. | .. | .. | .. | .. | .. |
| 5 | • | • | .. | .. | .. | .. | .. | .. |
| 6 | • | .. | • | .. | .. | .. | .. | .. |
| 7 | .. | • | • | .. | .. | .. | .. | .. |
| 8 | .. | • | • | .. | .. | .. | .. | .. |
| 9 | .. | • | .. | .. | .. | .. | .. | .. |
| 10 | .. | • | .. | .. | .. | • | .. | .. |
| 11 | • | .. | .. | • | .. | .. | .. | • |
| 12 | .. | • | .. | .. | .. | .. | .. | .. |
| 13 | • | .. | • | .. | • | .. | .. | .. |
| 14 | .. | • | .. | • | .. | .. | .. | .. |
| 15 | .. | • | .. | .. | .. | .. | .. | .. |
| 16 | • | • | • | .. | .. | .. | .. | .. |
| 17 | • | • | .. | .. | .. | • | .. | .. |
| 18 | • | • | .. | • | .. | .. | .. | .. |
| 19 | • | .. | .. | .. | • | .. | .. | .. |
| 20 | • | .. | • | .. | .. | .. | .. | .. |
| 21 | • | • | .. | • | .. | .. | .. | .. |
| 22 | • | .. | .. | .. | • | .. | .. | .. |
| 23 | • | .. | .. | • | .. | .. | .. | .. |
| 24 | • | • | .. | .. | .. | .. | .. | .. |
| Total | 16 | 14 | 7 | 5 | 4 | 3 | 1 | 1 |

temperature were rare (three subjects) and limited to reports of "warmth" in the phantom or in phantom parts. In only one instance a subject described his phantom sensation as "natural"—"as if you touched me with your hand." As already mentioned, one subject reported outright pain in the phantom: ". . . it's very painful only since last year. It wakes me up at night, a throbbing elbow (in the phantom). Before last year, I only had tingling and numbness." A summary of the individual descriptions of phantom sensations is given in Table 2.

It is apparent that the quality of phantom sensations in upper-limb amputees is rarely "natural," but also rarely painful. The protocols for each case included, in addition to descriptions of existing phantoms, a detailed history of the wounding, as recalled by the amputee. No evidence was found that the characteristics of the phantom were in any way related to the original physical trauma. Almost all the amputees sustained either shell-fragment or gunshot wounds. In eight cases, gangrene developed prior to amputation. In two cases, the limb was lost at the time of wounding. Some suffered pain, while others felt only a "dullness." Seven had their wounded arms encased in a plaster cast prior to amputation, and 14 underwent a subsequent surgical revision of their stump (2 had two revisions and 1 had three revisions). Notwithstanding these dissimilar conditions prior and subsequent to amputation, the sensations experienced by 23 of the 24 subjects were substantially similar. The exceptional case was the one with the intermittently painful phantom.

*Dimensions of the Phantom.*—"Extended" and "Telescoped" Limbs: During the examination, one subject volunteered that "the hand is actually in the stump, right at the end." Another said "I feel I have a hand sensation; it's in the stump and the fingers are close to the edge." Several others claimed "My ghost hand has decreased in length and is now in the stump," or "I feel the fingers . . . close to the edge . . .," or (when the examiner touched the tip of the stump) "Gee! It feels just like you are touching my hand."

All except two subjects reported that their phantom had "shrunk" over the years or that the distance between phantom fingers and tip of stump had decreased, as compared with the length of a normal limb. In 12 cases, the phantom hand had either completely entered the stump or was partly fused with it, so that only portions of the hand (fingers) were felt as "protruding." We have considered all such cases as instances of "telescoped" phantoms. The remaining 12 described their hand as outside their stump ("extended") either at normal distance (2 subjects) or with some shortening. Several men (five) insisted that the more proximal parts of the phantom had disappeared, leaving a "gap" in the phantom limb; the seven others described their phantom as extended into space without any gaps. After the interview, each subject made a pencil drawing of his phantom; several of these are reproduced in the Figure, which shows three characteristic "telescoped" phantoms, three "extended" phantoms with gaps, and three "extended" phantoms without gaps.

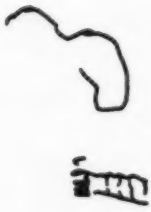
*Shape of Phantom and Relative Vividness of Parts.*—As the drawings show, the shapes of the phantom limbs differ from those of normal limbs. These differences are due partly to shortening, but even more to differential dropping out or "fading" of phantom parts (such as the arm itself, the elbow or wrist, or parts of the hand), as described by all subjects. The relative persistence of phantom parts was assessed by asking each subject to rank those parts that he did feel according to their respective vividness. The results are shown in Table 3; numbers refer to the frequency with which a given part was listed; for example, the fingertips were ranked "most vivid" nine times and once each in second and third place. The mean rank was computed by multiplying each rank for a given part with the corresponding frequency and by taking the sum of the products; thus, for the fingertips $(9\times1)+(1\times2)+(1\times3)=14$. This figure was then

SUBJECT 21

SUBJECT 5

SUBJECT 3

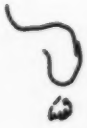
SUBJECT 7



SUBJECT 18

SUBJECT 10

SUBJECT 6



SUBJECT 22

SUBJECT 2

Drawings made by nine amputees illustrating their phantom experience: (*a*) "telescoped" (Subjects 21, 7, 6); (*b*) "extended" with gaps (Subjects 5, 18, 22); (*c*) "extended" without gaps (Subjects 3, 10, 2).

divided by the total frequency, namely, 11, yielding a mean rank of 1.3. In this way, an over-all rank order was obtained, despite the fact that most subjects ranked some, but not all of the phantom parts.

Fingertips, thumb, and all five fingers were ranked as most vivid with almost equal frequency (differences in their ranks were not significant); they accounted for 30 out of 33 "most vivid" ratings. Next in order were the index finger and the palm; wrist and back of hand were never rated as "most vivid." Forearm and elbows were mentioned less than six times by all 24 subjects, and never as "most vivid." Clearly then, the most prevalent and persistent phantom parts were the distal portions of the hand—either the fingers (collectively), or the thumb.

*Subjective Movement.*—The most frequent illusory movement of the phantom in our subjects was an impulsive "reaching" with the phantom hand. Of the 24 subjects, 21 said that they had experienced such spontaneous reaching movements in the months shortly after amputation. Nine of these twenty-one said that the inclination to reach for things with the nonexisting hand still persisted. As one subject put it, "I point with my stump and actually feel that I point with my hand. I often attempt to catch a ball when I play ball." Another amputee said, "When something falls, I'll jerk to grab it and the phantom [*sic*] will move." These spontaneous "reaching" movements usually appear as a response to a stimulus, and they should be distinguished from those involuntary movements that occurred apparently without stimulus. Such illusions of involuntary motion were described as uncomfortable and in our group were rather rare. Five subjects reported such motions in their phantom; their descriptions were similar and included reference to what seemed to be tonic and clonic features. They spoke of a "pulsating of the hand," ". . . the hand is opening and closing," ". . . the palm (goes) up and down," or "the fingers . . . are stuck . . . the hand drifts."

TABLE 3.—*Relative Vividness of Phantom Parts*

| Reported Parts | Vividness, Most to Least | | | | | | Mean Rank | Rank Order |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | |
| Fingertips.... | 9 | 1 | 1 | .. | .. | .. | 1.3 | 1 |
| Thumb..... | 9 | 2 | .. | 9 | .. | .. | 1.4 | 2 |
| Fingers..... | 12 | 8 | 2 | 1 | .. | .. | 1.6 | 3 |
| Index finger... | 1 | 3 | 3 | .. | .. | .. | 2.3 | 4 |
| Palm..... | 2 | 3 | 7 | 4 | 1 | .. | 2.9 | 5 |
| Wrist..... | .. | 3 | 2 | 2 | 1 | .. | 3.1 | 6 |
| Back of hand. | .. | 1 | 5 | 2 | 1 | 1 | 3.6 | 7 |

Half of our group—12 subjects—reported the ability to "will" movement in phantom parts, but this movement was restricted to distal portions. These men felt they could make a fist, and nine felt they could flex their fingers. This ability to move the phantom was unrelated to its subjective dimensions, since of the 12 who reported voluntary movement, 7 had "extended" and 5 had "telescoped" phantoms. Of the 12 men who felt they could make a fist, 7 said that flexion of fingers and closing the fist was "easier" than extension and opening. Five stated explicitly that they had marked difficulties in "straightening" their hand; they constantly experienced their phantom in a slightly flexed position.

A comparison of the distribution of tingling and other phantom sensations with those of voluntary movement showed clearly that the latter were less widespread and less persistent. The "pins and needles" sensation was experienced over a larger area of the phantom than that of motion; it was reported by more subjects, and it persisted for longer periods.

The majority of our subjects believed that they had some conscious control over their phantom sensations. All but 3 of the 24 felt that "concentrating" on their phantom (just as attempting to move it) tended to make it more vivid, while the phantom faded whenever their attention was otherwise engaged. These same men insisted that this phenomenon was still taking place 8 to 12 years after amputation. However, during the first months after the loss of the limb, phantom sensations were present for longer periods and were more readily brought back or intensified by conscious effort.

*Illusions.* — Penetrating Solid Matter: Some amputees reported a "queer" sensation when solid objects occupied the space which would have been occupied by their limb had it not been lost. Under these circumstances, the phantom limb was felt to be occupying the same space as the solid object. No subjective change took place in the usual alignment between phantom and stump. Such an experience was never reported by men with "telescoped" phantom limbs, but half of the group with "extended" phantoms (six subjects) described it vividly. In the others, the "extended" phantom temporarily disappeared to "give way" to the object.

*Persistence in Phantom of Position of Limb at Time of Trauma.*—It was difficult to ascertain from the interview data to what extent a phantom reflected conditions surrounding the original trauma. Each man was questioned about the posture assumed by his limb at the time of wounding; later (after 21 intervening questions), he was asked about the prevailing posture of his phantom. In 16 cases, no relation was noted between the posture of the phantom and that of the limb at the time of trauma; in the remaining 8 cases, similarities appeared between the description of the posture of the arm or hand during wounding and that given for the phantom limb. However, it was hard to evaluate these reports; some subjects seemed to be offering reasons to justify an experience (the phantom) which they could not explain in any other way. Of these eight men, seven had extended phantoms. One said concerning the moment of his injury, "My arm was outstretched [with upper arm at an angle to body]. I was speaking and holding the phone." In describing the present position of his phantom, he volunteered the statement that his "arm is outstretched as holding the phone when I was wounded." Another subject depicted his phantom arm as being "down on the side, like when running." He originally stated that he was hurt while running with a gun.

Aside from these doubtful reflections of preamputation posture in the present phantom, no subject in our group felt that sensations within his phantom limb perpetuated any particularly salient sensations experienced at the time of wounding or before. Even the one man with painful phantom did not think that his pain (which had appeared only recently) had any similarity with the pain suffered during or after the original trauma.

*Superadded Sensations.* — Some of the men—four—believed they felt on their phantoms the continuing imprint of objects worn on the limb for some time before amputation. One said he felt a watch around the phantom wrist, and the others claimed they felt rings on their phantom fingers. One reported he had felt his ring for a few months (after amputation), but had lost the feeling since then. (He was still married.) Another said, "I feel a ring because it was bent and tight and so I feel it . . . on the ring finger next to the pinky." The fourth man gave a description suggesting a peculiar dissociation, "I feel the ring on the finger that isn't there; that's the finger I don't feel, next to the pinky." Apparently, some relationship may have existed between particular experiences prior to amputation and later sensations in the phantom limb, even if the phantom was not painful.

*Relation to Prosthesia.*—To our surprise, we found no relation between the type of prosthesis (whether functional or cosmetic) and the dimensions, quality, or vividness of phantom sensations. Nor did it seem to matter whether a man had a prosthesis or not. Likewise, no consistent relationship emerged between the regularity with which a prosthesis was worn and the nature or vividness of the phantom. Of the 18 men who wore a prosthesis, 6 reported that the phantom appeared more vividly when the prosthesis was off. But five were equally insistent in saying that the phantom was more vivid when the prosthesis was on, and four said that the phantom was momentarily intensified when the prosthesis had first been removed. The remaining three stated that they felt no change in their phantom under any of these conditions.

COMMENT

*Prevalence of Phantoms.*—Our observations on amputees are in essential agreement with earlier ones on lower-limb amputees.[40] First of all, phantom-limb phenomena were common to both groups. Every one of our 24 amputees described phantom sensations which had persisted for over eight years. In the earlier study, 38 of 40 above-the-knee amputees experienced phantom sensations. A second point of agreement is the rarity of painful phantoms. Only one man in the present group, and three in the earlier study, complained of painful phantoms.

*Quality of Phantom Sensations.*—Painful conditions aside, the quality of phantom sensations is remarkably uniform in upper- and lower-limb amputees. The predominant description is that of a mild tingling ("pins and needles") sensation or a certain tightness referred to parts of the nonexisting limb. Amputees differed in their evaluation of these sensations, calling them moderately unpleasant, pleasant, or indifferent.

With the exception of one instance in the present group, neither upper- nor lower-limb amputees considered their phantom sensations as natural; they all reported the characteristic paresthetic quality. This quality was present regardless of whether contact with the stump elicited normal or abnormal sensations. Since the phantom experience was essentially uniform, it could not be due to rare and unusual conditions in the stump (as is sometimes suggested) or to special conditions existing before or after amputation. Among both upper- and lower-limb amputees, men with very dissimilar surgical histories had similar phantom sensations.

*Spatial Configuration.*—After removal of an upper or lower extremity, the size and shape of phantoms were rarely identical with those of a normal limb. Either immediately following amputation or during the first few months afterward amputees experienced a selective fading, or "dropping out," of certain parts of the phantom. The fading involved proximal portions (elbow, forearm, and wrist) more than distal ones. This sequence was analogous in the above-the-knee amputees of Teuber and co-workers, where fading involved primarily the thigh, knee, and shin.

As a result of this fading of proximal parts, either there appears a subjective gap in the phantom limb or the distal parts of the phantom come closer to the tip of the stump. This shortening of the phantom may have been somewhat more prevalent in our present group (upper-limb amputees) than in the lower-limb cases. In half of our cases, the distal part of the phantom not only approached but entered the tip of the stump; this too was reported by lower-limb amputees.†

Differential fading was observed among distal parts in consistent patterns. Thus, the palm was more persistent than the dorsum of the phantom hand, and when both were reported, the palm was more vividly felt. The thumb persisted more than other fingers; in fact, some fingers (especially the third and fourth) were often described as "vague" or even "missing." This recalls the situation in lower-limb amputees,[40] where the big toe was most distinctly felt and the other toes were either vague or "glued together."

The characteristic pattern of fading of phantom parts in arm and leg amputees supports, but does not prove, those theories which stress the role of central factors in the origin of phantom sensations. A static predominance of distal over proximal phantom sensations by itself is certainly compatible with a peripheral theory. Continuing stimulation in nerve stumps could evoke sensations which are referred outward (distal projection); there are more nerves coming originally from more distal parts, and thus distal sensations should prevail.[36] What cannot be explained in peripheral terms is the process of fading which extends over months and years. This process requires, at least, a mixed theory, such as Riddoch's suggestion of a gradually increasing suppression at central levels of the nervous system of sensations evoked by continuing impulses

† References 19, 20, and 40.

arriving from the periphery. Even more difficult for a purely peripheral interpretation is the unequal fading of distal parts. Similar issues are raised by the reports of voluntary motion in phantom limbs.

These "voluntary" motions are quite restricted; again, motions in distal parts predominate but involve an even smaller portion of the limb and are less frequent and persistent than the usual sensations of tingling Moreover, there is selectivity even within the distal pattern; flexor movements of the phantom hand predominate over extensor movements in both frequency and "ease." The finding recalls that of Teuber and coworkers in some of their above-the-knee amputees who complained that they could flex their phantom toes but were entirely unable to extend them.

In 5 of the 12 men who felt they could make a fist, flexion was the prevalent attitude of the phantom hand, just as in a paretic limb. Similarly, involuntary motions (repeated tensing, rhythmic opening and closing of the phantom fist) showed similarity with Jacksonian seizures. Such observations again point toward central rather than peripheral factors.

Our evidence is much less clear with regard to the nature of these central factors and the relative importance of learned and genetic patterns. Some estimates of the role of learning can be made by considering (*a*) the extent of individual differences in phantoms depending on experience before or during the trauma, and (*b*) the extent to which an existing phantom can be modified by experiences after the trauma.

Persistence of particular preamputation sensations, especially the pain of the original trauma, was not found in the present group, perhaps because there was only one case of painful phantom, and there the pain was of late onset. In the series of Teuber and co-workers, two of the three lower-limb amputees who had phantom pains described their pain as duplicates of the original pain felt at the time of wounding. Thus, one man who had been shot through the knee of the extremity which was subsequently removed "reported four years later an intermittent tingling sensation in the phantom foot . . . occasionally combined with flashes of bright pain in the phantom knee." ‡ The other amputee complained that his phantom foot felt at times as if he were "stepping on glass." Earlier in the interview he had described the pain of his original wounding in the same words. Ordinarily, he felt nothing but a mild tingling over the top of his foot. These cases illustrate persistence of pain felt at the time of the injury, but it should be noted that many other men also experienced pain at the time of wounding but did not acquire a painful phantom. Moreover, the two cases cited show that individual phantom pain coexisted with the commoner features of a tingling phantom.

Persistence in a phantom of preamputation posture was not reported by any of the lower-limb cases of Teuber and co-workers but may have been present in some subjects of our group. The descriptions were not altogether convincing; if accepted, they indicate that persistence of posture, at least in upper-limb amputees, would not be an exclusive feature of painful phantoms, as Riddoch and others had assumed.§ Again, however, it must be noted that the majority of our cases did not show such persistence of a momentary posture.

Persistence of superadded features in the phantom, such as rings or wrist watches, were likewise infrequent but were convincingly described by four of our upper-limb amputees. It must be assumed, for some subjects at least, that momentary experiences before amputation (such as a particular pain or posture) or longer-lasting ones (such as pressure from a ring) may survive in the phantom pattern. Certain events before amputation may thus modify the subsequent phantom experience, but this evidence must be balanced against the many instances of uniformity in phantom sensations, in spite of dissimilar preamputation histories and against the general lack of conformity be-

‡ Reference 40, p. 25.

§ References 3 and 18.

tween phantoms and normal limbs with regard to shape, size, and quality.

Evidence for modification of phantoms by postoperative experience is slight. We found no indications that the phantoms of our upper-limb amputees differed with presence or absence of prostheses, nor did the type of prosthesis seem to matter to those cases where a prosthesis was worn. This negative finding is somewhat different from observations on lower-limb amputees, where the prosthesis often tends to fuse with the phantom, making the phantom in some cases more vivid and of the same length as a normal limb.[40] Nor did we find for upper-limb amputees evidence for transient modifications in the phantom during urination or defecation. In the lower-limb amputees, acts of elimination were often accompanied by descriptions of tingling in the phantom foot and toes; even smoking has been reported to have similar effects.[40]

In general, our upper-limb amputees report phantoms which differed but little from each other; existing differences failed to suggest any obvious connection with individual differences in postoperative history.

Empiristic theories of the body scheme ‖ usually invoke early learning as the most important basis for awareness of one's body. The parts of the phantom which are most persistent are those which are most frequently used and for which the organism has acquired particular skills; however, these same parts also have denser peripheral innervation and larger central representations. Whether phantom sensations depend more on unlearned (structural) features or on learning cannot be decided on the basis of the present evidence. What is needed are observations on the presence (or absence) of phantom limbs in children and in cases of congenital absence of a limb. Likewise, we need information on the supposed failure of phantoms to appear in cases where there has been prolonged anesthesia of the limb prior to its removal. Regardless of the outcome of such studies, consideration of phantom limbs will help us in understanding the ways in which we experience, normally, the various parts of our body.

‖ References 6, 16, 33, 36, and 38.

SUMMARY

In a study of 24 male veterans (World War II) with unilateral above-elbow amputations (12 right, 12 left) all had illusions of continued presence of the lost limb. Data from structured interviews show that these phantom sensations are markedly similar despite differences in conditions before amputation. Sensations of tingling and "pins and needles" were reported most frequently; distal parts of the phantom were felt more vividly than proximal parts. Almost all of the amputees reported shrinkage and various degrees of telescoping (phantom in or near stump). The gradual fading of the phantom took place in a definite sequence, the proximal portions vanishing before distal ones. Where illusory movement of phantom parts was reported, motions of flexors were mentioned more often than those of extensors. The present observations, together with earlier ones,¶ are interpreted as supporting a central theory of the origin of phantom limbs.

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# On Phantom Limbs

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The presentation to follow does not claim to be a finished piece of work, or a survey of all the facts, or a theory which will settle the problem of phantom limbs once and for all. Rather, it is the result of a long-standing interest, occasional but fairly systematic examination of patients, with infrequent glimpses into the literature. Such sporadic activity is bound to raise more problems than it settles, but these problems themselves are fascinating, at least to my mind, and eminently worth while discussing.

In recent years psychiatrists have become interested in problems of amputation phantoms or, to be specific, in the motivational dynamics associated with painful amputation phantoms. Their discussions might at times lead us to believe that these are the only kind of phantoms, or at least the only ones worthy of note, despite the fact that while probably about 98% of all amputees experience phantom sensations for some time after the operation, only 1% or 2% have painful phantoms. Furthermore, there are phantoms — both painful and painless—which are not the result of amputation but rather of injuries to the nervous system, and these should not be omitted from a systematic discussion of the general problem.

There is of course a perfectly good reason for the interest of psychiatrists in the painful phantom—the search for ways of helping patients who suffer acutely. The same motivation directed earlier the attention of neurologists and surgeons toward the painful phantom. Some patients with painful phantoms have extremely severe pain, unrelieved by the usual analgesics. They go from doctor to doctor in search of relief; they become addicts of morphine, diacetylmorphine (heroin), and other drugs; some commit suicide in desperation. The procedures which have been tried out to help these patients have ranged from the most peripheral to the most central interventions. In amputees the most peripheral are secondary operations on the stump in an attempt to remove irritations due to the healing and scarring process: scars and neuromas have been excised, and repeated operations at successively higher levels have been performed. Weir Mitchell, who first introduced the term "phantom limb," [1] wrote that these procedures usually do not accomplish their stated purpose,[2] but this has not prevented multiple stump surgery in the intervening 85 years. Then, there have been attempts at interruption of the sensory supply of the stump by sectioning the peripheral nerve, the sensory roots, various tracts in the spinal cord, or by pharmacological blocking at these levels. Some have attempted also to cut or block the autonomic supply at the periphery or the ganglion. Even cortical sensory and/or motor projection areas of the affected parts have been excised by a few who had read Henry Head's observation.* Head had a patient who lost a leg and had an amputation phantom. Some time later the patient suffered a stroke which abolished the phantom. A few similar cases have been reported since. And then there are the various procedures for relief of what has been called the distressing affective component of pain, irrespective of its locus, or perhaps even of the pain itself: frontal lobotomies, electroshock, posthypnotic suggestion, and, in recent years, psychotherapy of one kind or another. To date it looks as if all these procedures are equally disappointing: none seem to

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* References 3 and 4.

have helped a significant number of patients for a significant period of time. Almost all can claim that they have helped some patients for a brief time and perhaps an occasional patient for a longer time, possibly even permanently. One difficulty is that so often follow-ups are lacking beyond the usual three- or six-month period. Follow-ups are somewhat longer for psychotherapy,† but not enough cases have been published as yet to evaluate the results.

That there is an important motivational component in at least some and perhaps the majority of painful phantoms cannot be doubted by anyone who has come in contact with such patients or who has even read the casual comments by the authors of published cases. It is my impression, however, that not all painful phantoms are of one kind and that some that are so labeled turn out to be something quite different on examination, for instance, painful stumps with normal, painless phantoms. However that be, it would appear to be a mistake to regard the painful phantom as the prototype of all phantoms and to interpret the whole range of associated phenomena in terms of the psychiatric element. In the first place, as has already been mentioned, only about 2% of all amputees have painful phantoms, while perhaps 95% have normal, nonpainful phantoms and 2% or fewer do not seem to have any phantom experience after amputation. Secondly, there are some systematic differences between normal and painful phantoms. Third, patients with normal painless phantoms make fine subjects for experimentation and are often very much intrigued by their own unexpected discoveries concerning this strange, and yet so intimately familiar, experience, while patients with painful phantoms are much more difficult to study, partly, but by no means only, on account of their intense suffering.

For all these reasons I shall concern myself almost exclusively with the normal phantom and shall discuss painful phantom material only when it is specifically relevant. The source of my own interest in the topic is simply this: I cannot think of any other phenomenon, any other set of facts, from which one can tease out quite as elegantly the separate contributions of basic normal anatomy and physiology; of normal learning in the course of the development of the individual; of special motivational components, that is, the psychiatric problems, and of the influence of certain social and cultural factors. Of late also, philosophers concerned with the nature of man have become interested in this topic, especially the phenomenologists and specifically the existentialists [7]; for the present, however, we shall forego a discussion of their writings. It would also be my hope that a review of the basic normal phenomena might be helpful to those who are especially interested in the pathology of the phantom, that is, the painful phantom, and that it might facilitate studies of that special, and clinically so important, problem.

Phantoms occur with a large variety of relatively sudden anatomical or physiological interruptions of the sensory supply of the affected part of the body. The best known phantoms are of those following amputation of limbs; that is, patients with amputations of an arm or a leg continue to experience the limb's presence, even though they know that it is no longer there. In general this holds whether the amputation has been carried out proximally or distally, whether at the shoulder, above or below the elbow, through the wrist, or at the finger joints; whether it is above or below the knee, through the ankle, or foot, or of toes. Phantoms are also observed after removal of other protuberances of the body, such as the nose, the eye, the nipples, the penis, and, in women, the breast. But, as has already been mentioned, amputation phantoms are not the only types of phantoms. There are phantoms of limbs denervated rather than amputated. The actual interruption of the sensory supply may be located at almost any level of the nervous system. Phantoms occur typically after plexus lesions, in transverse lesions of the spinal cord, and in certain types of cerebral lesions, especially thalamic lesions. The total and relatively abrupt elimination of afferents to

† References 5 and 6.

the part in question appears to be the only precondition, and this would account for the lack of phantoms with sections of the peripheral nerve which result in sensory loss of only part of the affected arm, hand, leg, or foot. In cases of neurological lesions the limb is of course still present, and the phantom experiences consist either of reduplication of the limb or of the same limb but in a position different from its actual position or of sensations which can no longer be mediated since the sensory pathways have been disrupted. A paraplegic patient lying in bed with his legs stretched out under the covers may feel as if his legs were drawn up, either over his abdomen or to one side. This experience may or may not disappear when the cover is removed and the patient can see the position of his legs. With other lesions we can observe duplication of limbs. A patient of ours with a thalamic lesion and a paralyzed and anesthetic left arm had a painful phantom of another left arm; this additional arm, projecting from the left shoulder, was going through painful torsion movements in the shoulder and ended up by pounding her back. Similar experiences have been described with lesions of the brachial plexus [8] and evulsion of the sensory roots, and they may continue long after the associated pain has subsided.

It is equally important to note some conditions under which phantoms do not occur. In the first place, many authors comment that phantoms are not found after amputations in the feeble-minded.[9] I do not know of any systematic investigation of this, but it is reasonable and might possibly account for the 2% of patients mentioned above who do not have phantoms. Incidentally, in this connection, psychotic patients have amputation phantoms much like normals except insofar as they may be elaborated by the special psychotic content of the patient.‡ Secondly, throughout the literature we find frequent reiterations of a rather casual comment by Pick [12] to the effect that congenital aplasias and amputations in early childhood do not result in phantoms. As far as I know, Pick's comment was based on his general understanding of the problem rather than on any evidence from patients who had been examined with a view toward answering this particular question. Nevertheless, one must admit that at least with respect to amputations in childhood, about which we now do have some evidence, he was correct. Riese [13] published a note in 1950 concerning 24 children with amputations whom he had examined; he could find no evidence for amputation phantoms below age 6 or 7. I have recently reanalyzed the data from the 122 amputees of Cronholm [14] and found no incidence of phantom in his four patients whose amputations had been performed before age 5. Two patients with amputations of the right thigh at age 5 still had phantoms 19 and 34 years later, respectively. Apparently the incidence of phantoms increases in the next decade, so that by age 15 phantoms occur as frequently as in all later age groups, that is, in practically all amputees. With regard to congenital aplasias we still don't know; we certainly would not expect phantoms, but as far as I know nobody has really looked into the matter.§

The same basic problem can also be explored in the study of patients with absorption of digits due to leprosy. Earlier this month I spent a few days at the National Leprosarium, Carville, La., and examined 18 patients, most of whom had had both surgical amputations of limbs due to infection, gangrene, etc., and absorption of digits in

‡ References 10 and 11.

§ In 1905 Souques and Poisot reported a case of bilateral amputation of hands at age 2 months. When examined 16 years later the patient had not had any phantom experience at any time, nor could phantoms be evoked by faradization or needling of the stumps. The same authors also mention the absence of phantoms in a patient with congenital absence of the left arm.[15]

Two years ago Dr. John Steelman, of Phoenix, Ariz., told me of two patients whom he had examined. One, a girl of 10 with congenitally absent arms, apparently had never had any phantoms. The other, seen at age 38, had lost his right arm when 3 years old and had never had any phantom. A stellate block produced pain in the shoulder but no phantom arm pain.

other extremities.|| The clarity of the results almost surpasses one's most hopeful expectations; phantoms appeared following surgical amputation but were absent following loss due to absorption. In this group there was a total of 20 amputations of leg or foot, and in each instance the patient had a vivid phantom of the part removed, which in most cases had persisted over many years. By contrast, there were 15 instances of absorption of digits without surgical intervention, and none of these had given rise to a phantom at any time. In addition, there were eight instances of surgical amputation of digits—and in one case the nose—after a good deal of absorption had taken place, and in every instance phantoms were present. By contrast, five patients who had had recent and relatively minor surgery of absorption stumps or had had muscle transplants in a hand in which the fingers were largely absorbed experienced no phantoms in connection with these. These results, that is, phantoms with amputation and absence of phantoms with absorption, are all the more striking as they come from the same patients who experienced phantoms in the one case and not in the other.

Phantoms make their appearance usually as soon after the insult as the patient is conscious and at all aware of his surroundings. In cases of amputation the patient often wakes up from the anesthesia and asks the nurse when he is going to be operated on. On being told that his arm or leg has already been removed he may not believe it until the covers are removed and he can see that the limb is indeed no longer there. There are occasional newspaper stories of a child of grade-school age who has been in an accident necessitating amputation and, the story reads, the child has not been told yet about having lost a leg. This must imply a phantom, because otherwise it would be impossible to keep it from the child; he would know without having to be told. Only occasionally is there a delay for a few days or even as much as two or three weeks after amputation before a phantom is reported. The reasons for such delay are not at all clear. Surgical shock, intense stump pain, febrile conditions, etc., may be responsible in some cases, but certainly not all, and even these conditions do not necessarily or even typically prevent the immediate appearance of the amputation phantom. The situation is much the same for phantoms after neurological lesions, although spinal shock appears to be a real factor in delaying phantom experiences of some paraplegics and a minimum of recovery seems to be requisite for the appearance of phantom after insult to the central nervous system.

The duration of amputation phantoms appears to vary widely; some seem to disappear within a few months, while others are still vividly present 20 or 30 years after surgery. While patient-to-patient variability is undoubtedly great, it is my impression that many authors have, in the past, underestimated the life of the phantom. Often one finds statements to the effect that the "average" amputation phantom runs its course over a two-year period, at the end of which it has disappeared. I suspect that once the phantom reaches a certain stage some authors have been inclined to assume its cessation without further study. Even so, there are frequent reports that phantoms which seem to have disappeared may recur many years later, even decades later, owing to a variety of circumstances, such as further surgery on the stump, the wearing of a prosthesis, and sudden, though perhaps very minor, emergencies. Thus, the ringing of the telephone may waken a patient who jumps out of bed to answer it and, "having forgotten about the missing leg," falls down. Or a patient may trip over an obstacle and, in order to steady himself, reach out for a support with his phantom hand.

Phantoms in patients with plexus lesions or spinal cord transection also seem to last for many years; every one of Bors' 50 paraplegics examined from two months to eight years after injury reported phantom sensations.[16] Cerebral insults producing phantoms seem to be of two kinds: those in which the

|| Dr. Rolla Wolcott, Clinical Director, U. S. P. H. S. Hospital, National Leprosarium, Carville, La., invited me to examine these patients and he and his staff aided me in this study.

pathological process is reversible, in which case the phantom disappears in the course of recovery, and those where the pathological process is progressive, in which case the phantom may disappear once a certain stage of deterioration has been reached or may persist as long as the patient is conscious. Such cases are relatively rare, and detailed studies of them have yet to be made.

When the phantom first makes its appearance after amputation, plexus lesion, or spinal cord transection, it is in general experienced much like the normal limb before injury or amputation. It is usually characterized by normal shape, size, consistency, position, superficial sensitivity, and both voluntary and reflex movements. There are, however, important exceptions. The phantom of a limb which had been deformed for a long time before amputation may be similarly deformed, and the phantom of a part which had previously been paralyzed for a long time before injury may be immobile. It is a popular misconception that the phantom assumes the position of the limb at the moment of injury; only in some patients with painful phantoms is the phantom indeed reported as maintaining what might be called "the last moment of life" of the limb. Voluntary movement of the phantom is absent in many patients with painful phantoms, probably largely as a function of the patient's apprehension over a possible exacerbation of pain with attempted motion. Movement is also absent in many paraplegics with and without pain. Then there are reports of the initial phantom being larger or smaller than before injury. Phantom limbs which are "too large" seem to be reported primarily in amputees, where the phantom limb can be compared to the contralateral healthy extremity. On the suspicion that lateral dominance might be responsible for such reports, I have begun to check the literature. The first three cases confirmed my suspicion; all three concerned amputation phantoms of right limbs in presumably right-handed persons, but any conclusion must, of course, be based on the examination of many more cases. Phantoms of initially smaller than "correct" size might similarly result from amputations on the nondominant side. However, for these phantoms there is also a simpler and much more obvious explanation, namely, that the description was obtained not soon enough after the amputation but after some time had elapsed and when the normal reduction of phantom size was well on its way, a development which will be discussed presently. Furthermore, it is my impression that initial small phantoms are reported more frequently in patients with spinal cord lesions than in those with amputations or plexus lesions and that such descriptions are typical of high cervical as well as thalamic and cortical lesions where the phantom tends to reduplicate the affected parts. No systematic study has been made of this as yet.

Thus, the typical initial amputation phantom manifests itself in the following ways: The patient on awakening from the anesthesia may not be aware that the part has been removed. The foot of the amputated leg may tingle and itch, and, as the patient reaches down to scratch it, he reaches for an empty space. He may feel the bedsheets on the arm or leg; he may feel a mild, perhaps pleasant tingling—a phenomenon which Henderson and Smyth [17] regard as basic. Thus one patient recently told me that "the leg felt good . . . real good." Sometimes the absent extremity is described as feeling swollen, numb, or tight without being painful, and, of course, some patients experience pain. The patient, despite his "knowledge" of the amputation may "forget"; he may try to get out of bed or out of his chair, step on the foot which has been removed, and fall. The patient experiences reflex movements in the missing arm or leg as he adjusts his position in bed or in the chair, and he feels that he can wiggle his fingers or toes and flex or extend the wrist or ankle and that he can perform these movements more or less at will. Not infrequently the patient is more aware of the phantom extremity—even though painless—than he is of the contralateral intact limb, an observation already recorded by Weir Mitchell [1] and possibly one more reason for the occasional reports of increased phantom size.

One additional feature is still to be mentioned here: the alignment of the phantom with the stump, and its capacity to penetrate solid objects without any sensation of touching them. A patient with a midthigh amputation lying in bed may feel his phantom leg flexed at the knee, with the lower part hanging down through the mattress, yet without experiencing any contact with the mattress. Or, with the patient sitting in a chair, an object may be gradually approximated to the stump until it touches the latter, without either changing the phantom's alignment with the stump or producing a phantom touch sensation. The phantom seems to go blithely through the object, and the experience seems to be so "natural" to the patient that it is rarely commented upon spontaneously.

Most of these features hold also for the nonamputation phantom. In general, the phantom here coincides with the paralyzed limb, although this is not always the case. It has already been mentioned that the initial phantom legs of some paraplegics are experienced in abduction, either to the side or over the abdomen of the patient, while the paralyzed legs are in extension. Sometimes initial phantom legs in these patients are reported as even more dissociated from the real legs, as almost floating in the air above the real legs, but this is relatively rare. Despite the marked position characteristics of the paraplegic phantoms, voluntary movement of the phantom is often limited to wiggling of the toes, and sometimes it is altogether absent from the beginning. This is in marked contrast to phantoms after brachial plexus lesion, which appear to be characterized by both position and voluntary movements, much like the amputation phantom, and this despite the fact that there is often much initial pain.

Reduplication seems to have been reported almost exclusively for patients with high cervical transverse lesions, with lesions in the thalamus and in the cerebral hemispheres. The phenomenon consists of phantoms coinciding with the paralyzed limbs plus extra phantoms of the same limbs. Thus, one patient with a high cervical transection reported sensations in her stretched-out paralyzed arms and legs and, in addition, a second set of arms and legs, smaller than the first and neatly folded over her chest and abdomen respectively. A patient with a thalamic lesion who was mentioned before felt her paralyzed left arm as much shortened and had an additional left phantom arm which went through painful torsion movements which she begged us to stop since she had no control over them.

So much for the initial phantom experiences. But phantoms do not persist without change until they suddenly disappear, or at least they ordinarily do not. Under certain exceptional conditions this does happen, for instance when a patient with a phantom incurs brain injury, or has a stroke, or undergoes brain surgery for relief of pain, or under condtions of very extreme physiological stress.[18] Nonpainful phantoms of amputated limbs exhibit an orderly progression of changes, some aspects of which are shared also by painful phantoms, by amputation phantoms of parts other than limbs, and by nonamputation phantoms.

At first the patient reports that the painless amputation phantom feels much like the limb before amputation, or like the healthy contralateral arm or leg. But a short time later the account is somewhat different. Now the patient may feel some parts only very faintly, while others continue as vividly as ever. In time these faint parts tend to fade away altogether, while other parts previously vivid may pale and still others persist with undiminished clarity. The parts which fade first are the upper arm and the thigh, while the lower arm, calf, joints, hands, feet, and digits are maintained. Next, the lower arm and the calf disappear, to be followed by the joints and eventually parts of hands and feet, leaving perhaps only the toes, the instep, the heel, and the lateral margin of the sole of the foot or the fingers, the palm, and the ulnar part of the hand. Still later, only phantom toes and fingers may be experienced, and of these the great toe and the thumb, index finger, and little finger outlive the other digits. These changes take varying lengths of time and in some patients never run their full course.

The sequence of disappearing parts follows, with the possible exception of the joints, the Penfield-Boldrey homunculus.[19] Those parts which have large areas of representation on the homunculus, which are richly endowed with sensory fibers, making for high sensory acuity and fine discrimination, and, on the motor side, which have high innervation ratios and represent discrete and skilled movements rather than power are the very same parts which have the longest phantom life. By contrast, those which have minimal representation on the homunculus are relatively short-lived as phantoms.

The second type of change is the famous telescoping, which is intimately related to the disappearance of some parts of the phantom while others persist. It is of interest to note here that the patients can report the locus of the various phantom parts without any hesitation and with great precision. When parts of the phantom first begin to fade, the position of the remaining parts is unchanged. The patient may no longer have a phantom thigh, but the remainder of the phantom limb is in its usual and proper place. At this stage the patient is not aware of any holes or empty spaces between the stump and the remaining phantom parts. For some patients there then follows a period during which they experience the emptiness of the interspace, and they describe the persisting phantom as disconnected, as "floating down there" in its normal accustomed place and position; but this does not appear to be true of all patients, or perhaps not enough attention has been paid to it by most investigators. In any case, this is almost always a transient stage. Phantoms and their owners seem to abhor a vacuum as much as nature is said to do, and so we find the separate parts moving together and approaching the stump. This is also a gradual process and essentially the same for upper and lower extremities. In the absence of a phantom calf, and with both phantom foot and knee present, the foot gradually rises, being felt after a while at a place halfway toward the knee, then just below the knee, then projecting from the knee. As the phantom knee disappears, the phantom foot may be localized where the knee would be, above the place where the knee would be, and eventually at the stump. And after that? For some patients it seems that once the phantom foot has reached the stump it begins to fade, leaving after a while only the toes, and eventually these disappear too, temporarily at first and then for progressively longer time periods. But in some patients something else can be observed; perhaps it could be found in all on careful examination. The phantom foot may remain intact and gradually slip into the stump, with the toes sticking out longer than the heel. Gradually, the stump comes to enclose the whole foot, which may be felt within the stump for a long time before it disappears. If one is in luck and catches the right patient at just the right time, that is, before the foot has disappeared into the stump, one can make some very pretty and, to the patient, often very amusing experiments. Not long ago I was in luck when I saw a patient with a high thigh amputation and a phantom foot just outside the stump. If you took a book or, better still, the hospital chart with the metal backing and gradually approached it toward the stump, the phantom foot seemed to penetrate it, just as would be true of the full-length phantom. But at the moment when the cold metal touched the stump, the phantom slipped inside the stump, only to be out again as soon as the stimulus was removed. This could be repeated many times in succession without extinction and without particularly fatiguing the patient. Various authors have reported similar experiments. Apparently this works only with phantoms which have undergone a great deal of telescoping, perhaps because the stump cannot accommodate phantoms longer than itself.

The third type of change in amputation phantoms consists of a diminution in size of the remaining phantom parts. While some authors comment on this, it is often not mentioned, and, from my own experience, I know that it is easily overlooked, perhaps because the dropping out of parts and, especially, the telescoping are so much more impressive changes. It has happened to me that after several interviews with a patient I believed

the phantom to be of normal size, simply on the basis of the patient's spontaneous description. But when specifically asked to compare the size of the phantom foot to the healthy foot on the other side, the patient would immediately reply that the phantom foot was much smaller, perhaps only half of normal size, perhaps even less. Just when the reduction in size of the phantom begins, to what extent it is a gradual progressive development, and its relationship to other changes in the phantom is not clear at all at this time.

Apparently all these changes, that is, the dropping out of parts, the telescoping, and the reduction in size can be prevented, slowed down, halted, or reversed, and even, once the phantom has disappeared altogether, it can be provoked into reappearing. Among the conditions are pain, peripheral stimulation, the use of a prosthesis, and central stimulation.

Pain: Painful phantoms may be retained in their entirety for a long period of time without undergoing any of these changes. Some patients with painful phantoms are aware only of certain parts, for instance, the fingers and palm of the missing arm, but telescoping or changes in size do not ordinarily take place under these conditions. However, in patients with localized pain in the stump and normal painless phantom, the normal phantom undergoes the usual changes except that it seems to show some reluctance about disappearing into that painful stump. Furthermore, I have seen a patient with a high thigh painful stump and a normal, nonpainful, and much telescoped phantom when she was relatively free of pain; during bouts of stump pain she was not aware of this phantom at all, but instead experienced a phantom extension of the thigh beyond the stump, apparently as a function of radiating pain which was provided in this way with a field for the pain to radiate into.

Peripheral stimulation: Even in nonpainful phantoms irritation of the stump by electrical stimulation, as a result of a fall, or on reoperation can temporarily reverse the telescoping and may reconstitute the phantom to its full size and extension and complete with parts that had previously disappeared. This holds true even for phantoms which had previously vanished in their entirety. More surprising, perhaps, such stimulation seems capable of provoking phantoms when there had been none before: There is the example of the patients with leprosy, much absorption of digits, and then amputation and/or major repeated surgery resulting in phantoms; there is also the case reported by Riese [13] of a boy whose left leg was amputated at age 6 without a phantom resulting until the stump was revised, three years later, when a normal painless phantom appeared.

Prosthesis: The effects of the prosthesis on the phantom vary somewhat both from patient to patient and with the site of amputation. Typically, though by no means invariably, when the patient begins to use the artificial limb the phantom reverts to its full size and extent, even though it was much telescoped before or had even totally disappeared, but it may remain incomplete insofar as parts such as the forearm or the thigh and calf may be missing. There are, however, cases on record in which the phantom became extinguished once a prosthesis had been fitted to the stump; it is my impression that this is relatively rare.

Phantoms of the lower extremities often coincide with the prosthesis; that is, the patient comes to experience the prosthesis as a living member, much as he experiences his leg on the other side, and is literally walking on the phantom. One lady told me recently that sometimes when she gets home in the evening she takes off both her shoes, that is, she takes off the shoe of the healthy leg and then finds herself unlacing the shoe of the prosthesis. Other patients seem to have a phantom in parallel with the prosthesis, a phantom which moves with the prosthesis but is clearly distinguished from the latter. In still other patients the phantom leg, though clearly present, does not participate in walking at all, while still other patients report absence of phantom sensations when walking with the prosthesis.

The relationship between phantom arm and artificial arm appears to be somewhat more uniform than that between phantom leg and prosthesis. A number of authors mention that phantom arm and prosthesis very rarely coincide, that each retains its autonomy. The prosthesis tends to be experienced as a tool, attached to the stump and without life of its own, and this seems to hold regardless of whether the patient wears a hook or a dress hand. Cronholm,[14] in commenting on the difference between phantom-prosthesis relationships of upper and lower extremities points out that the leg prosthesis is used for walking in much the same way as the leg, and therefore prosthesis and phantom can coincide, while the hook is used for manipulations which differ very much from the activity of a normal hand, and the dress hand cannot be utilized at all, and these differences account for the lack of coincidence between phantom and prosthesis of the upper extremities.

Central stimulation: An amputation phantom which has disappeared for all practical purposes may reappear suddenly when the patient is forcefully reminded of the original accident or some circumstance in connection with the amputation. It may recur on seeing another amputee or in dreams of the patient. Voluntary concentration may bring it back, though certainly not in all patients.

The changes described here for the nonpainful phantoms of amputated limbs do not generally apply to all phantoms. It has already been mentioned that there is usually neither telescoping nor change of size of the painful phantom, although it may lack the more proximal parts. I have seen no description of such changes in amputation phantoms of other than limbs and have not observed any in the few cases of this category that I have examined. Phantoms in paraplegic patients also show no telescoping and probably no diminution in size, but they may be incomplete, consisting primarily of the distal parts, especially the toes; very marked size reduction has been described by several authors in reduplicated limbs, especially after high cervical transection resulting in quadriplegia. Where spinal cord transections and amputations exist side-by-side, the amputation phantom tends to be experienced more vividly than the phantom of the present, though paralyzed, contralateral limb; at the same time, such an amputation phantom apparently does not undergo telescoping. In phantoms due to cerebral lesions both increase and decrease of phantom size has been noted, the latter probably more frequently, but there is no telescoping and probably no disappearance of the proximal sections of the phantom.

I shall now mention three separate questions and show for each the general direction in which I think we must look for the answer. These questions are the following: 1. Why do phantoms occur at all? 2. Why, once having appeared, do certain parts drop out selectively while others persist for much longer periods of time? 3. Why do amputation phantoms go through a process of telescoping?

1. Why do phantoms occur at all? The answer to this question must be given, I think, in terms of a schema which each person develops of his own body. Head's concept of the body schema [8] based on postural, kinesthetic, and tactile learning from earliest infancy would appear more fruitful here than the concept of later authors in which visual and/or motivational elements are in the foreground. These latter elements are important: The visual element may account for the long persistence of phantoms in paraplegics, and the emotional elements are undoubtedly important factors in painful phantoms. But for the normal painless phantom postural, kinesthetic, and tactile elements seem to be of primary significance, not only in the genesis of the body schema but also in the phantom experience proper, which consists of postural, kinesthetic, and tactile sensations. It must be remembered that the body schema is acquired as a function of peripheral stimulation and over a period of time. Apparently it reaches a certain degree of stability first at the age at which other types of perceptual activities also stabilize. Around age 6 most children

are capable of the types of visual-spatial organization requisite for learning to read and write, and it is at about the same age that amputation phantoms first appear. The body schema must constantly undergo minor changes and revisions, following the gradual changes of the body as mediated by the periphery. In patients with leprosy, peripheral anesthesia, and gradual absorption of digits the body schema can keep up with the changes in body shape and no phantom results. Under conditions of amputation or acute neurological lesion, on the other hand, the body schema is left "way behind," as shown by the presence of the phantom, whose persistence indicates how long relearning takes under these conditions.

2. Why, once having appeared, do certain parts of the phantom drop out while others persist for a much longer time period? This question, I think, must be answered in terms of the Penfield homunculus and its behavioral repercussions. Large homunculus areas represent highly differentiated sensitivity and movements to which we ordinarily give most attention, while small homunculus representation means low absolute and differential sensitivity and relatively automatic movements. The correlated experiential aspect may be called—for lack of a better term—degree of awareness. We are ordinarily much more aware of our fingers than of our upper arm, of our toes than our calf. If, as one might assume, the changes in body schema with reference to the lost part consist in gradual reduction of awareness, then those parts of which we were relatively unaware to start with will soon disappear below the threshold of awareness, while those which are very prominent in our experience would offer great resistance to being abolished.

3. Why do amputation phantoms go through a process of telescoping? This, it would seem, is a function of the fact that, once parts drop out, the phantom becomes disconnected from the rest of the body—which is a disturbing state of affairs. Theoretically, one of two developments could take place, either of which could bridge the gap: The remaining parts could "stretch" so as to contact the stump, or they could move toward the stump. But "stretching" would mean change of shape and thus loss of object identity; incidentally, it would also tend to increase the size of the phantom parts—thus working against their disappearance. Change of position, on the other hand, does not abolish object identity, nor does it prevent other changes such as reduction in size. Unfortunately, while a good deal of work has been done on object identity of visual stimulus figures there is none to my knowledge on problems involving postural and kinesthetic material.

There are of course many other aspects of phantoms which could be discussed. The preceding descriptions are by no means exhaustive of all the phenomena and the conditions under which they occur. But in tracing the larger outlines and the most general facts I hope to have provided a solid basis for the analysis and consideration of their systematic implications. The voluminous literature covering almost a century of discussion concerning the origin of phantom experiences can be summarized in a single sentence: Is the seat of the phantom to be located in the periphery, specifically the neuroma; in the brain, or in the soul? With some notable exceptions, most authors have aligned themselves with general views prevalent at their period: The earliest writers favored the periphery; in the second decade of the present century the brain found most champions, and in the last few years the soul has come into its own. Briefly, my argument is that events at the periphery are a necessary but not sufficient condition for brain function and that physiological brain function is similarly a necessary but not sufficient condition for phenomenal experience. Furthermore, while the relationship between periphery and central nervous system is comparatively direct, the brain-experience relationship involves, at least genetically, a time delay during which learning takes place. Under conditions of amputation or sudden neurological isolation,

the phantom may be understood as a direct outcome of this delay.

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## Special Articles

# THE PRACTICE OF PSYCHIATRY AROUND THE WORLD

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FROM a study of the psychiatric facilities around the world during the past 31 years and a four months' visit to many of these facilities during this past winter, it is evident that the world has slowly come to accept psychiatry as an essential branch of medicine. In numerous countries the medical profession and the public in general are beginning to give up the hopeless and disparaging attitude which in the past was associated with neuropsychiatric conditions. In some places psychiatric patients are still considered in terms of incarceration or custodial care, and the terms lunatic, insanity, and asylum continue to be used; unfortunately, such is the case even in some localities in the United States. But in general the situation has improved, and most practitioners in this field have kept up with the times. In most countries it is not the practitioners who need enlightenment, but the public authorities who need to be jarred from their lethargy and shown the gravity of the situation. The progress of a nation's psychiatry is a good index of the country's stability.

In every country the psychiatric facilities were overcrowded, the staffs were inadequate, the budgets were at a minimum, and there was little uniformity in psychiatric thinking and therapy. In almost every city one practitioner dominated the picture, and he was very jealous of his authority. In many cases, his practice of psychiatry was essentially a dogmatism, and he held himself aloof from the general practitioners of medicine and surgery.

In the United States, Canada, and England, women psychiatrists were found to be common; but, outside of Manila, women in the Far East have yet to take their rightful place in this specialty, although they are going into medical schools in increasing numbers. Only one woman physician in psychiatry was found in each of the following places: Hong Kong, Singapore, Cochin, and Bombay; two were in Colombo, but none in private practice. Psychiatric social workers and psychologists, the handmaidens of psychiatrists, were not found outside the English-speaking countries, except that one trained psychiatric social worker is employed in Japan and two in Ceylon, and clinical psychologists are in practice in India, the Philippines, and Japan.

Around the world the organic approach to psychiatry seems to dominate the field, and the psychological or psychoanalytic approach appears to be on the descendency. The art of extended psychotherapy and social integration is being lost, or has never been found, in many places. This situation evidently has been greatly influenced by the dogmatic religions and the fear of governmental dictatorship. Very few free thinkers were found in this survey, and it is, therefore, logical that the shock and brain destruction therapies are in increasing use in every country. The chemical therapeutic agents, such as the bromides, paraldehyde, chloral hydrate, and the barbiturates, are still popular, and now there is a general experimentation with the two drugs reserpine and chlorpromazine. Hydrotherapy has practically disappeared. Occupational therapy is used to a limited degree, and a great majority of the patients remain idle. Psychiatry, even in the United States, appears to be looking for a get-well-quick formula, rather than a realization and a clarification of the well-known fact that the disintegrated personality can be helped to proper integration only by the balancing of the mind and

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body. This requires not only chemical balancing but painstaking social and psychotherapeutic insight and direction. The patient must be helped to understand self and the purpose of living.[1]

The terminology used in the diagnoses of the patients in almost every country is essentially the same as that in America,[2] and, without exception, "schizophrenic reaction" was the diagnosis found for the majority of the patients seen in every country.

From statistics, mental illness appears to be on the increase throughout the world. Perhaps the modern way of life is increasing the stresses, for automobiles are everywhere, as are American drinks, American movies, American magazines, American songs, American music, American gadgets, and the demand for American tempo. Although we are censoring the horror comics in the United States, the industry has dumped these trash sheets on the Far East. The problem has become so great that in a number of places legislation is being made against these etiological agents. The structure of the stable family is being broken up; security is being lost, and divorce is on the increase. The world is awakened, and more people are being educated, but there are not enough jobs for these intellectuals. The stark present is what they have. The past is irrevocably gone. The future for them seems unattainable, however much they may strain toward it. Perhaps they will attain stability, or perhaps they will go mad.

### THE UNITED STATES OF AMERICA

The United States, with a population of 160,700,000, according to the Surgeon General,[3] has 725,000 mentally ill patients, occupying nearly half of all our hospitals, and 250,000 new patients will be admitted during the next 12 months. More than $1,000,000,000 is spent each year to care for these patients, but progress in psychiatric practice "has been discouragingly, tragically, dangerously slow." Our psychiatric hospitals, both state and private, are overcrowded and understaffed. Young physicians of the right type are not going into this specialty in the numbers that are needed. Of 216,000 physicians in the United States, 153,858 are members of the American Medical Association, and only 8821 are specializing in psychiatry.

There is a schism in the psychiatric profession between the analytically orientated practitioners and those who look to organic modalities in treating their patients. A few physicians fit their treatment to the patient, and not the patient to the treatment. In many places the East Coast is in disagreement with the West Coast, while the middle states battle for supremacy and publicize spectacular success with therapy. Freud still dominates the picture in New York, but Jung appears to be in ascendency on the West Coast. Hollywood has a hundred psychiatrists, and Los Angeles is plagued with clinical psychologists of sorts. New York has an encroachment of psychiatric social workers and lay practitioners, out of control. The movies and TV are overselling psychiatry, to the detriment of good practice; yet most of our medical schools do poor service in selling psychiatry to the oncoming generation. There is now an overselling of neurosurgery, with the recommendation to cut out the brain and stop the emotions. Many general practitioners follow the instructions of the drug houses and prescribe each magic potion as it comes out, in an attempt to calm the troubled personality.

### CARIBBEAN ISLANDS; CENTRAL AND SOUTH AMERICA

The Caribbean Islands and Central and South America do not welcome inspection, and it is evident that those who practice psychiatry are content with what is being done. The organic approach dominates the picture.

The latest report [4] indicates that there are about 60 psychiatrists in practice in Cuba, with its 5,300,000 population, and 11 psychiatric hospitals, with 3400 patients. In Argentina, with its population of about 13,500,000, they say 156,000 need psychiatric care. Brazil, on the other hand, with its

population of well over 41,000,000, reports only about 6000 patients in the psychiatric hospitals. Mexico, with 20,000,000, reports about 5000.

### THE PACIFIC ISLANDS

Hawaii has a population of half a million, with 300,000 in Honolulu. There are psychiatric clinics and excellent hospital facilities, but most are under reorganization. It is difficult to retain an adequate psychiatric staff, and there are no psychoanalysts in the Islands. It was said the private practitioners get rich quickly and retire. One thing is certain: Races and creeds live together without friction.

Islands of the Trust Territory, such as the Marshalls and Marianas, are now in transition. Here were areas that were hardly touched by civilization until World War II, when the American armed forces came in and brought with them conflict and strife.[5] These people had no guilt about the past and no ambitions for the future. Man was born to laze in the sun, to love and to be loved, and so he could express his emotions. But the white man is out to destroy this paradise, and bring neuroses and psychoses to these islands, where such were not previously known.

### JAPAN

A report on Japan in 1930 said that "the treatment of psychotic individuals, with few exceptions, is still dependent on superstitious beliefs and is left mostly in the hands of the priesthood."[6] A report of 1953 states that there are 3 national, 17 prefectural and municipal, and 125 private psychiatric hospitals for the 88,200,000 population. It further states that there are 41 general hospitals with psychiatric wards.[7] A report in 1954 states that there are 27,000 beds for psychiatric patients, which take up only about 7% of all the beds in Japan. This Japanese psychiatrist estimates that there are 700,000 psychotics in Japan.[8] He further states that there are about 800 psychiatrists in Japan. Our recent survey brought out that there are 19,000 physicians in Japan, 900 of whom are in psychiatry, and 60% of these are in private practice. Most of these have their own private hospitals or clinics, and much of their income comes from custodial cases. About 90% of the patients are cared for under state social insurance. One of the leading psychiatrists stated that it would be impossible to make an adequate living by private office practice alone.

Japan has regressed in psychiatry during the last third of a century. Early in the century the area was dominated by German psychiatry, and today she lives in the past and is afraid of the future. The psychiatric facilities and equipment are outmoded, and, although the winters are bitter, none of the hospitals are heated. None were fireproof. Not one adequate hospital was found, and even the general hospitals were second-rate according to American standards. All psychiatry is subsidized by the state, and psychotherapy is at a minimum. They say patients will not pay for "talk." There is only one psychoanalyst in the country, and the single trained psychiatric social worker has a heartbreaking uphill job. Most of the psychiatrists seen appeared calloused, but one or two had real feeling for their patients. The Japanese psychiatrist quoted before [8] states that "Japanese psychiatrists as a whole are very research-minded." Certainly, the physician's authority is never questioned by the patient.

The problems of psychiatry are increasing, with increasing suicide, divorce, alcoholism, and amphetamine addiction. There is a conflict between the ironclad traditions of the past and the demand to come up to the speed and glamour of American life. Thus, amphetamine (Philopon), the "awakening drug," is used increasingly and is taken by injection as many as 100 times a day. After three or four months a psychosis may develop, with hallucinations and delusions.[7] Alcoholism is also a major problem, and cyanimide sulfide is used as a deterrent.

Taking all the psychiatric hospitals, the reports show that 54.3% of the patients have schizophrenic reactions, while one superintendent said he had 70% schizophrenic reactions and about 12% dementia paralytica.

It is interesting to note that manic patients are seldom seen, and restraint, therefore, is not used. Electric and insulin shock therapies are used without hesitation, and all the psychiatrists stated that fracture never occurs in the Japanese patient nor does he claim any discomfort after treatment.

### CHINA AND HONG KONG

Thirty years ago China had only one scientifically run psychiatric hospital, and, according to reports, this hospital still exists in Canton, although it is now only a custodial institution for the most disturbed. The family is still held responsible for the actions of its members, so that the compulsive and psychotic patient may be chained at home or locked in a back room. A survey,[9] carried out in 1925, resulted in an estimate of at least 3,120,000 neuropsychiatric cases in China, and one of every 126 sick persons was a neuropsychiatric problem. At least 43% of these cases were psychotic; so there were 1,341,600 such patients in China, a figure which undoubtedly was a great underestimate. There is no reason to believe this number has decreased; rather, it has no doubt increased under the insecurity of recent years. With the claimed population of 600,000,000, the present figure would be at least 1,787,000 psychotic patients. Yet there are only eight psychiatrists in all China.

From the best available reports, there are no national government hospitals for the insane in China. In Peiping, the capital, there was a place that was called a hospital for the insane, but it was nothing more than a prison in which psychotic persons were confined and sometimes put in chains. In Canton, South China, about 1200 miles away, there was a Municipal Insane Asylum, in which several hundred patients were herded together. Christian missions did a little more for these unfortunates. There was a small Roman Catholic hospital in Shanghai for 20 patients, and two or three Protestant mission hospitals set aside a ward for mental cases. The only large institution devoted wholly to the care of psychiatric cases was the John G. Kerr Hospital, in Canton, which had a capacity of about 700 patients, although the unsettled condition of the country caused it to close, until necessity forced the Communists to open it again. Soochow had a small "insane asylum" outside the city, under the charge of the Presbyterian Mission. The Peking Union Medical College did not provide any separate accommodation for mental cases, although it reported treatment of psychotic cases, both Chinese and foreign. For the care of foreign psychotic patients, Shanghai offered a limited ward for a few acute cases, and the Hankow International Hospital had one room for mental cases.

After China was closed to non-Communists, the Hong Kong Mental Hospital became increasingly overcrowded, with its 370 beds and an admission rate of 1000 a year, while the surrounding population, of 2,500,000, steadily increases every day. There is only one trained psychiatrist, and he is assisted by one male and one female physician, assigned by the local health authorities. The report of the superintendent states, "Much resort had to be made to electro-convulsive therapy, and, to a lesser extent, leucotomy, because of the increasing difficulty of supervising chronic excited patients in conditions of gross overcrowding."

There are no psychiatrists in private practice in all of China, and psychotherapy is considered a waste of time. It is interesting to note that the aforementioned psychiatrist was being sued for $250,000 on a claim of unjustified detention by a patient at the time we visited Hong Kong. But later reports state that the claim was dismissed by the British court.

### THE PHILIPPINES

The influence of the United States is still evident in the Philippines, with its population of 21,000,000, but its psychiatry is dominated by the dictates of the Roman Catholic Church. Education is a fetish, with far more college graduates than can be adequately employed.

The State Mental Hospital has a 1200 capacity but had 3186 patients and a staff of 20 doctors. There is one adequate treatment building, but most of the facilities are given over to the worst of custodial care. One dark room, about 30×100 ft., was crowded with 200 patients, herded together worse than animals, without furnishings of any kind. The staff, on the other hand, appeared sincere and anxious to do their best, even with limited facilities. Psychotherapy was very limited, and most patients were treated with electro- or insulin shock. Restraint was seldom used, except in the form of paraldehyde, barbitals, or shock. Those who were able to pay for their accommodations were treated better than the charity cases.

The Army Hospital has better accommodations, with a 100-bed neuropsychiatric ward, two physicians, and one psychologist. Unfortunately, the chief of service is a neurosurgeon who appears to be ice-pick-happy and carries out a transorbital lobotomy on the slightest provocation. Much is being spent for the army and little for public health.

There are no psychiatrists in private practice, and psychoanalysis is obviously taboo on these islands. A small clinic is operated by the Mental Hygiene Society.

### AUSTRALIA

Australia has a population of nearly 9,000,000, half of whom live in the capital cities and larger towns, although there are some 46,000 full-blooded aborigines living mostly in the sparsely settled subtropical zone, and another 74,000 half-castes are congregated near country towns. Each of the six states has its own department of mental hygiene, which administers its own psychiatric hospitals under "lunacy" laws, which differ from state to state. These hospitals contain 27,400 beds, staffed by 128 whole-time medical officers, although in New South Wales a few visiting practitioners relieve the resident psychiatrists by carrying out periodic physical examinations in the chronic sections. Private psychiatric patients are treated in small nursing homes or in the private sections of the general hospitals. Australia does not have a comprehensive national health service, as in Great Britain, but the general hospitals have a total of some 45,500 beds, with 4400 attending and 1500 salaried physicians.

Postgraduate education in psychiatry is offered to general practitioners by means of lectures and clinics. Special courses toward the diploma in psychiatry are provided for medical graduates at the four medical schools. The Sydney Institute for Psychoanalysis has three fully trained medical psychoanalysts and two candidates in training. There is also the Melbourne Institute of Psychotherapy, and it is evident that psychoanalysis is not used much as a method of treatment. Dawson [10] says, "It is not yet possible to speak of any distinctive school of psychiatry in Australia, but it is sound and conservative rather than enterprising or experimental." The Australian Association of Psychiatrists has 104 ordinary and 52 associate members.

In 1949 the lithium treatment for states of excitement was introduced. Doses of up to 10 grains (0.65 gm.) of lithium citrate or carbonate are given three times a day; but if the compound is given for any length of time, toxic symptoms may develop, and death has occurred even after the administration had been discontinued for some weeks.

### NEW ZEALAND

New Zealand has a 2,000,000 population, and the country is geographically isolated and tends to be cut off from certain cultural trends. The populace regards mental illness with horror, and psychiatry until recent years has been a government monopoly. All but one of the mental hospitals in the country come under the direct jurisdiction of the Health Department, and thus the policies affecting them are dependent on one man, the Director of Mental Hygiene. There are no child guidance clinics in New Zealand, or outpatient services. The advances in the

physical treatment of mental disorder were most reluctantly accepted. The first two E. C. T. machines used in New Zealand were donated to the Mental Hygiene Service privately in 1943. Until recently the medical superintendent of the Mental Hospital in Dunedin had to refer to the Department before he could consider carrying out a neurosurgical operation on a patient. Psychotherapy is largely ignored, and psychologists and psychiatric social workers are not used. The mental hospitals have difficulty in retaining a medical staff. Because of rigid administration through the years, they have lost a number of their best men. The medical establishment, if complete, would not come up to anything like the A. M. A. standards. However, a recent move has been made to provide mental hospital doctors with study leave to obtain higher qualification and training.

There are two psychiatrists who are wholly engaged in private practice, although one of these is doing so after many years in the State Mental Hygiene Service, more as a hobby in retirement than a livelihood. There are two other qualified psychiatrists, who hold general hospital appointments and are salaried but do private practice. One other psychiatrist, the medical superintendent of the only private mental hospital (60 beds), is allowed private practice to the extent of 40% of his working time. There are four other doctors, without formal training in psychiatry, who limit their practice to private psychiatry, and quite a number of general practitioners devote a considerable proportion of their time to psychiatry. One physician, who has had some training in psychiatry, runs a private clinic, mainly staffed by lay people, but the New Zealand branch of the British Medical Association does not recognize his work. Then there are four lay analysts, who have a thriving practice.

### SIAM

Thailand, with a population of 20,000,000, has a very modern psychiatric hospital of 600 beds and 7 physicians in Bangkok, as the king is sympathetic to psychotic patients. This is really a show place. On the other hand, he has a real problem on his hands, for the country economically is being taken over by the Chinese and Indians and the Siamese are becoming indifferent to their future.

### MALAYA AND SINGAPORE

Like Hong Kong, Malaya, with a population of almost 6,000,000, and especially Singapore, are under the dominance of the British. Singapore is essentially a Chinese city, as 85% of the population is Chinese. There are no psychiatrists in private practice, and the best facilities are at the Woodbridge Hospital, Singapore, which is not overcrowded, with its 1182 men and 750 women patients in a 200-acre plan, with six doctors. Two are qualified psychiatrists. The hospital has three classes of patients: charity patients, and those who pay $3 and $10 a day for services. It has an ambitious program and provides for a psychologist and six psychiatric social workers in its budget. All forms of therapy are used, but there is definite antagonism to psychoanalysis. A psychiatric clinic is conducted at the General Hospital, and thus many patients avoid the necessity of certification to the hospital.

The rest of Malaya has two psychiatric hospitals, and the superintendents of each are Britishers, who are absolute authorities. Their opinion in psychiatric matters is never challenged. One of these men said there was no future for the white man in the Far East and that all white men in Malaya were "wacky." He said the reason that E. C. T. was popular with the natives was that they felt all mental aberrations were due to possession by spirits, and that the electricity drove out the evil spirits.

### INDONESIA

The group of islands known as Indonesia has a population of 78,000,000, without adequate psychiatric facilities. There are more than 100 different types of people living on these islands, from head-hunters to mod-

ern Europeans. The Dutch established a mental hospital 100 years ago at Bogor (Buitenzorg), and later one at Sabang, but these were destroyed during the war. There are only 5000 beds for mental patients in this whole area. There are three psychiatric hospitals in Java, and the British are building another in Borneo, similar to the one in Singapore. There is only one psychiatrist in private practice in this area, and one psychiatric clinic at Batavia.

### CEYLON

Ceylon has a population of 8,300,000 and has been self-governing for the last seven years. The best-conducted psychiatric hospital in the entire Far East was seen at Angoda. The staff has 11 physicians, of whom 6 are qualified psychiatrists. One is a psychoanalyst. The hospital also has four other physicians in psychiatric training in London. It has no psychologists, but it does have two social workers and two more in training. It also has two trained occupational therapists. Unfortunately, the hospital is overcrowded, with its 1800 capacity, and 4300 patients: 2400 men and 1800 women. This hospital has a section for private patients at $1 or $2 a day. These facilities are excellent.

A new addition for 500 ward patients is being opened the first of next year at Mulleriyawa and could well be a model for psychiatric hospitals, as it is constructed in open units, with 12 patients to a room. There are no bars or screens, and the buildings are one-floor, cottage plan, with spacious grounds.

There is a psychiatric clinic and a child guidance clinic at the General Hospital, Colombo. There are three neuropsychiatrists, entirely in private practice, and hospital staff members are allowed to do private consultations.

The Ceylonese are to be congratulated on the progress they have made and the plans they have for the future. There was less prejudice and bigotry found here than in any other place visited.

### INDIA

India has a population of 372,000,000, and there are 60,000 qualified physicians, of whom 14,000 are members of the Indian Medical Association. Only 25% of the physicians are in private practice. Most of the trained psychiatrists are in the armed services, but all federally employed physicians are required to spend 2 of their 25 years before retirement working in one of the government psychiatric hospitals.

According to the Bhore Committee, there are 700,000 mentally sick patients, and only 10,000 beds available in the 19 state psychiatric hospitals, with 80 psychiatrists in all of India. The three best institutions are at Bangalore, Agra, and Ranchi, but the hospital at Thana, just outside Bombay, is an example of most of the facilities. It was founded in 1901, and there are 690 male and 525 female patients, cared for by 4 physicians, 9 graduate nurses, and 22 attendants. The superintendent is the only person with psychiatric training. The facilities are essentially nothing more than iron-barred cells without any furniture. The patients sleep on the concrete floor. There is an admission rate of 40 a month and a discharge rate of 22. Sixty insulin shocks and about the same number of E. C. T.'s are given each weekday. There is no classification of the patients, who are treated as criminals, many of them stark naked and sitting in their filth. Flies and mosquitoes swarmed about. There were few, if any, shade trees, and there were no screens. The hospital at Trichur, Cochin State, which serves a community of 1,000,000, has a capacity of 110, but actually has 286 patients, but no psychiatrists. Conditions are even worse than at Thana.

In the city of Bombay, with 3,500,000 people, there are 9000 physicians, of whom 3000 are specialists. Only six, more or less trained, limit their private practice to psychiatry. There are, nevertheless, several clinical psychologists and lay psychoanalysts, and five physicians are now in psychiatric

training. Only one of the psychiatrists limits his practice to psychotherapy.

There are psychiatric clinics at the Topiwala National Medical College, the Grant Medical College, and the G. S. Medical College, and they are building a psychopathic hospital. At present they have a 24-bed neuropsychiatric ward in the K. E. M. Hospital, with a shock clinic, and an outpatient clinic, which cares for 2000 patients each year. The Mental Hygiene Committee conducts a Child Guidance Clinic and a Marriage Clinic.

The country is beset with 600 different religions, innumerable poor, a few indifferent rich, and countless beggars. The hospitals are overcrowded, and a valiant attempt at supplying psychiatric care for acute cases is being made. Private psychiatric patients are cared for inadequately in nursing homes, which are crowded and dirty. The standards of sanitation in Indian hospitals are far below those in America. Every form of crime, sadism, prostitution, drug addiction, and alcoholism is found in the big cities.

It is interesting to note that the drug obtained from Rauwolfia serpentina, which is heralded by the western world as a great discovery from India for the treatment of psychiatric conditions, is hardly used by the "legitimate" profession in that land. True, it has been used for many years by the native medicine men for the treatment by hypertension, insanity, and snakebite.

### PAKISTAN

Pakistan is a new country, with 76,000,000 people, plagued with ancient traditions and much prejudice. Karachi is now a city of 1,500,000, and a population of 2,000,000 is expected within five years. There are 1400 qualified physicians in all of Pakistan, with only 470 members of the medical association. There are about 80 physicians in psychiatry, but only 5 are doing private psychiatry and only 2 of these devote their full time to private practice. There are two state psychiatric hospitals in Pakistan, with 3500 patients, but another hospital, of 1000 beds, with an acute psychopathic hospital of 100 beds, in Karachi is planned.

Unfortunately, the psychiatric thinking is in confusion and is intermingled with the dictates of religion and a popular demand for shock treatment.

### EGYPT

Egypt is trying to break with the past and obviously discourages any interference from foreigners. There are 22,000,000 people, with two state psychiatric hospitals of 20,000 patients. In Alexandria, with 1,500,000, there is only a small psychopathic hospital, of 20 beds, and it sends two patients a month to the state hospital, although many are sent direct by the police. These hospitals are "run as prisons." Near Cairo, with 3,500,000 people, there is a private psychiatric hospital of 90 beds, with one full-time psychiatrist and six part-time physicians. This hospital is conducted as a training institute, and all forms of therapy are used.

There are few psychiatrists in Egypt, and none devote themselves wholly to private office practice.

### ITALY

Italy, with 47,250,000, has a well-established system of psychiatric hospitals but a wide diversity of psychiatric thinking. In 160 psychiatric institutions there are 89,000 beds, cared for by 684 physicians.

Although Sicily is a part of Italy, it is distinctly different, its natives having a penchant for crimes of violence. There are two state hospitals, with 2000 patients each. It is said that not a day goes by on the island without several stabbings among the 4,500,000 population.

Naples has the largest university in Italy but is indifferent to psychiatric advance, and its policies are dictated from Rome. Psychiatric illness is considered a disgrace, and a patient's family hesitates to admit that an "evil spirit" has possessed a member.

Genoa is a very old city, with a population of 700,000, and is very proud of its tradi-

tion and its 150-bed neuropsychiatric clinic at the Medical College. Northern Italy is more psychiatric-minded than the South, and patients actually ask for admission to psychiatric hospitals. The approach is, nevertheless, mostly organic, and shock therapy is popular. The staff of the clinic is composed of neurologists, neurosurgeons, neurophysiologists, and psychiatrists, and members assume importance in this order. All the physicians do private practice, even though they are employed by the state, as the salaries are low and two-thirds of their income comes from seeing private patients. No adequate salary is earned until a physician gains the rank of professor.

Psychoanalysis is not popular in Italy and is said to be confined to Jewish physicians. The emphasis is put on neurology. There is much use of amphetamine and the barbiturates. The shock therapies are popular, but permission for lobotomies is difficult to obtain. Large doses of chlorpromazine are used in depression, and reserpine has been found very effective in excited schizophrenic cases. Psychologists and psychiatric social workers are not used. Patients are tied to the bed if restless, although individual confining rooms are not used. Wrist and ankle straps are standard equipment in the 1500-bed state hospital. Otherwise, the equipment is of the most modern type and is kept very clean.

### FRANCE

In France, which has a population of 42,500,000, there is a definite move away from the purely psychological approach to psychiatric problems, and there is a tendency to think that physical factors are of primary importance. In all the educational centers, such as Paris, Lyons, and Marseille, the problems are attacked as a team. This is made up, as in Italy, of the neurologist, the neurophysiologist, the neurosurgeon, and, lastly, the psychiatrist. Eighty per cent of their income is from state insurance, and 80% of the population is insured. Alcoholism appears to be one of the major psychiatric problems in France.

In Marseille, with a population of over 600,000, there are two state psychiatric hospitals, with a total of 3000 beds. Another hospital is to be built within the next two years. It is evident in Marseille that neurology dominates the field. There are 15 civilian physicians and 3 military physicians in neuropsychiatry in Marseille. Also, this city is the headquarters of the Foreign Legion, which has a large general hospital and research center, including a 150-bed neuropsychiatric ward. An electroencephalogram is done on every patient. At this center a study is going on in the use of sleeping sickness as a treatment for schizophrenia. Reserpine is not used, but chlorpromazine has been found effective in excited and manic patients if large doses are given.

### BRITISH ISLES

The United Kingdom has a population of 50,500,000, and has over 300 psychiatric hospitals, with over 150,000 patients. It would appear that British psychiatry dominates most of the Middle and Far East, and Maudsley Hospital, London, is the training center for the psychiatrists going to those areas.

Nearly every psychiatrist of standing in the British Isles is either a whole-time worker, under the National Health Service (N. H. S.), or a consultant working seven or nine half-days a week under the N. H. S. The N. H. S. has benefited psychiatry in some respects. It has provided some whole-time research workers, who organize research covering several hospitals, and such men are often given equipment worth thousands of dollars. Since the N. H. S. started, there have been about a dozen new professorships of psychiatry which are whole-time. There is a tendency nowadays for those working whole time in psychiatry under the N. H. S. to have greater prestige because they can teach and organize research. There is, however, a difference between those who are at teaching hospitals and universities and those who are wholly under

the N. H. S. The former are controlled by a medical school or university. Some of these, especially in the London teaching hospitals, such as Maudsley, are part-time in private practice. They have a higher prestige than those who are under the N. H. S. entirely.

There are few psychiatrists of any standing under the age of 65 who are engaged solely in private practice. Many men retiring at 65 enter whole-time private practice. Practitioners in London entirely in private practice have greater prestige and practice on a higher level than those under the N. H. S.

British psychiatrists of the future will be most interested in being experts in planned research. The best are likely to be full-time, with salaries of $10,000 to $15,000, while others will have part-time private practices. In their cases expenses and taxation make it impossible to earn more than the above.

An example of planned research is that done at the Powick Mental Hospital, where they are using *d*-lysergic acid diethylamide to help patients tell about the mental processes which preceded their psychoses. This drug temporarily makes a person feel and behave like a schizophrenic. He withdraws from reality, and his image seems to him to become larger or smaller. A division in the sense of individuality may appear, so that one part of the person may seem to be watching the other. Many become talkative, whereas others lose the power of speech for a while. Some persons scream or cry or have violent outbursts. Consciousness is retained, although it may become unrelated to the environment. Some persons may experience hallucinations and fantasies.

As in the United States, there is a schism in psychiatry in the British Isles, as there are the neurologists, the psychologists, the psychoanalysts, and the psychosomatists. The use of hypnosis has attracted much attention. Psychoanalysis and shock therapy are freely used in London, while Edinburgh practices conservative psychiatry. A practitioner in the Isle of Man has a large following because of his use of mysticism. Yet on the mainland the standard psychiatric clinic is found in many centers, composed of a psychiatrist, a psychologist, and psychiatric social workers.

### CANADA

Canada, with its 14,500,000 people, has 84 psychiatric institutions, with 51,370 beds and 61,010 patients.[11] The annual admission rate is 16,000. In spite of this overcrowding, Canada has been progressive in the practice of psychiatry, which is essentially the same as that found in the United States. Each province has its own hospitals, but since 1948 the federal government has assisted in this program through the Division of Psychiatry of the Department of Health and Welfare in Ottawa. Most provincial hospitals are adequately equipped, but there are only 471 physicians employed, and only 366 physicians in Canada are certified psychiatrists. The practice of psychiatry, nevertheless, has now attained the status of acceptance equivalent to that of the other specialties in medicine: Seven hundred physicians so limit their practice.

A recent trend has been toward integrating psychiatry with other community services, and there is an increasing number of small psychiatric units developing in the general hospitals. These units are designed to provide facilities for observation pending diagnosis and for short-term therapy for cases that do not need continued care. A patient is usually admitted on the same basis as to other general hospital departments; if, after an observation period and diagnosis, the psychiatrist in charge of the unit considers that the patient may benefit from continued care, the patient is transferred to a provincial mental hospital or to a psychiatric hospital.

The psychiatric hospital differs from the mental hospital in that it is designed to provide intensive short-term treatment for patients with a favorable prognosis. Most of these psychiatric hospitals, of which there are 10, are affiliated with major universities and are closely integrated with the universities' training and research programs. Pa-

tients who require custodial or prolonged care are transferred to the mental hospitals.

Many general hospitals also have outpatient departments and stationary and traveling clinics. There is a concerted effort in Canada toward removing the stigma that has been attached to mental illness, and public education along this line has been intensified.

Research in psychiatry has just begun. Because of the difficulty of obtaining adequate support during the past years, relatively few studies have been carried out at the universities, but since World War II several federal agencies have established grants for extramural research. Although Canadian psychiatrists have borrowed considerably from the Freudian concepts, the use of analysis is limited. On the other hand, the use of the team of the psychiatrist, the psychologist, and the social worker is common practice. Also, the neurologist and the electroencephalographer are commonly found. Canada was early in adopting shock therapy, but they are now extensively using chlorpromazine and reserpine.

## SUMMARY AND CONCLUSIONS

The psychiatric facilities, both state and private, in 30 countries around the world were studied. These findings were compared with the observations made three decades ago, and it is evident that during these last 30 years psychiatry has made many advances and is now accepted as an essential branch of the practice of medicine. The following conclusions are drawn:

1. There is an increase in mental illness throughout the world. The people of the world are emotionally in a turmoil.

2. There is a universal shortage of properly trained psychiatrists, and there is no world-wide standard for training in this specialty.

3. The psychiatric hospitals and clinics in every country are overcrowded and understaffed. Custodial care is still dominant.

4. The organic approach to psychiatry is on the ascendency, whereas the art of psychotherapy is on the descendency.

5. The private-office practice of psychiatry is still not popular outside the United States.

6. The progress of a nation's psychiatry is a good index of the country's stability.

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# Society Transactions

## NEW YORK NEUROLOGICAL SOCIETY AND THE NEW YORK ACADEMY OF MEDICINE, SECTION OF NEUROLOGY AND PSYCHIATRY

George H. Hyslop, M.D., *President, New York Neurological Society, Presiding*

*Joint Meeting, Jan. 10, 1956*

**The Supersensitivity of Chronically, Partially Isolated Cerebral Cortex as a Mechanism in Focal Epilepsy and Lobotomy.** DR. FRANCIS A. ECHLIN.

In 50 monkeys and 1 human, areas of cerebral cortex were neuronally isolated or partially isolated, and in 4 monkeys frontal lobotomies were performed. Seven to ten months later 0.2% acetylcholine applied to the cortex caused wave-and-spike discharges selectively from the isolated or partially isolated areas. The resting discharge in the electrocorticogram from such partially denervated areas at times resembled that seen in an epileptogenic focus, and when dilute ACH or physostigmine and ACH was applied to it, focal cortical seizures, and even prolonged status epilepticus, occurred in some animals.

In the chronically lobotomized monkeys bipolar electrodes were placed 8 mm. anterior to the lobotomy incision and 8 mm. posterior to it. The degree of injury and of ischemia was apparently essentially the same at each pair of these electrodes. However, when acetylcholine (0.5% to 1%) was applied to the cortex, it caused selective firing of epileptiform activity from only the electrodes anterior to the incision, over the lobotomized, partially isolated area. The supersensitivity demonstrated was, therefore, apparently due to the isolation factor, and not to injury or ischemia.

The findings provide further evidence that Cannon's law of denervation applies to the cerebral cortex and that the supersensitivity of partially denervated nerve cells around the periphery of brain tumors and cortical scars may be the basis of focal epilepsy in such cases.

It has been demonstrated that lobotomy caused a profound change in the physiological chemistry of the partially isolated cells (a supersensitivity) in the frontal lobe, and probably elsewhere. It is therefore suggested that the clinical effects of lobotomy may be, in part at least, the result of this supersensitivity.

DISCUSSION

DR. H. HOUSTON MERRITT: It is a great pleasure to hear Dr. Echlin present the results of his studies, which are of great importance to those of us who are concerned with the problem of convulsive seizures. The more one deals with this problem, the more it would seem that patients with convulsive seizures have some damage to their brain to account for their attacks, and that the hypothesis of idiopathic epilepsy becomes less tenable.

It is self-evident that a completely isolated area of the cortex would not, no matter what was done to it, affect the rest of the brain. It could not produce a discharge that could be transmitted to other parts of the brain and produce a convulsion. A small, or large, area of the brain that has been partially deprived of its connections could conceivably be hypersensitive because it is deprived of a number of its synapses. Synapses have an inhibitory, as well as a stimulating, role. If a great many of the inhibitory influences acting on these cells are destroyed, they could become hypersensitive to various types of stimuli. Dr. Echlin has stated that the partially isolated areas are hypersensitive to acetylcholine applied topically and to pentylenetetrazol (Metrazol) injected intravenously. It is quite probable that they are sensitive to a great variety of chemical and other agents. Now, how could this hypothesis be made applicable to the problem of convulsive seizures in man? Is this hypersensitivity a manifestation of Cannon's law of hypersensitivity to a specific neurohumor, or can we interpret it in another way?

Dr. Echlin's studies would suggest that the outlook for finding a cure for epilepsy is less hopeful than it was when it was thought that there was possibly some generalized metabolic defect underlying the convulsive state. The problem then would be to find some agent which

would correct this metabolic defect and thus cure the seizures. If all seizures, or the majority of seizures, are focal seizures (and Dr. Echlin has limited himself to this aspect) and are due to damaged cortex which is partially isolated, then therapy of convulsive seizures resolves itself into either excision of the irritable focus or damping the hyperactivity by some chemical agent. Dr. Echlin would probably be one of the first to say that surgery is not the answer. We should not be unduly discouraged, however, because the chemists are now isolating many chemical compounds that can affect the activity of the central nervous system, and it is conceivable that a chemical compound will be discovered that will influence the activity of hypersensitive cells without depressing normal cells.

DR. BENJAMIN HARRIS BALSER: This is an excellent presentation. May I suggest to Dr. Echlin the consideration of depth-electrode studies along the same lines as he has been following, particularly in the animal? It would be interesting to know what effects one could see in terms of depth electrodes.

DR. ABRAHAM M. RABINER: Cortical cell discharges are the end-result and sum total of the many influences converging on that cell from many other areas. When the cortex is isolated, as Dr. Echlin has done, are we justified in speaking of these discharges as the result of cell supersensitivity? Would it not be more accurate to say that these cells, having been cut off from the normal influences of inhibition, modulation, etc., exerted by these other areas, are not necessarily supersensitive but their responses are uncontrolled?

DR. GEORGE H. HYSLOP: I would like to ask Dr. Echlin how he is going to distinguish between anatomic, or structural, and physiological, or biochemical-physical, bases for the abnormal cell reactions he described.

I have in mind the fact that patients with idiopathic epilepsy have no known structural or anatomic characteristic pathology of causal nature and that electroencephalographic abnormalities may be tranmsitted from one generation to another, whether or not seizures occur. I have in mind also the fact that both focal and grand mal seizures occasionally are precipitated as a result of exposure to a specific allergen, with no background whatever to imply an organic structural defect.

DR. FRANCIS A. ECHLIN: I would like to thank Dr. Merritt for his excellent discussion, and also the other discussors.

Dr. Merritt brought up the question whether the supersensitivity that has been described is an example of Cannon's law of denervation. I really do not know whether this is an example of Cannon's law, but it seems to conform to many of the things he has observed in peripheral structures. The phenomenon of supersensitivity in the chronically isolated areas of cortex is in keeping with this law. However, I have described supersensitivity in acutely isolated cortex, and this is not in conformity.

I think perhaps one thing is of value in this work; if these supersensitive areas of cortex that I have described really represent epileptogenic cortex when they are partially isolated, then we have, almost for the first time, a preparation where we can study epilepsy, and produce it experimentally, if, as I say, this is epilepsy. I do not know whether it is or not. It is true we can produce epileptic seizures with alumina cream, but this is a chemical irritant that does not produce a physiological state, as isolation does. Now, with unlimited preparations, like the one described, we can study the effect, for instance, of glutamine, as Donald Tower has been doing on human epileptic cortex removed by Penfield.

As far as a study with depth electrodes is concerned, which Dr. Balser suggested, I think that that would be an excellent thing.

Dr. Rabiner, I believe, asked whether the cause of the supersensitivity is that the connection of cells has been cut; if the connections have been cut, then the cells have been denervated, and all I can say is that they then become supersensitive; they may be described as hyperirritable, and this may be because they are released from other cells.

Dr. Hyslop asked how to distinguish between the anatomic changes and the physiological changes in these cells which we have seen manifested as high-voltage discharges from partially isolated areas of cortex. The latter is a physiological manifestation of epileptiform discharge. Anatomically, many of these cells do show some changes, and I am hoping that Dr. Stevenson and some other people will help us to describe these anatomic, or, rather, pathologic, changes later.

**The "Dieting Depression": Untoward Responses to Weight Reduction Regimens Among Certain Obese Women.** DR. ALBERT J. STUNKARD.

In recent years the physical ill-effects of excess body weight have been firmly established, and there is strong evidence that reduction to a so-called "ideal weight" can obviate these ill-effects. Thus, to ancient cosmetic reasons there have been added powerful medical pressures upon obese persons to reduce, and upon their physicians to collaborate in such attempts. There is reason to believe that the over-all effects have been desirable. However, for a large number of overweight persons the resultant widespread mechanical prescription of reducing diets has had unfortunate consequences. For a smaller number it has been disastrous.

Fifty-one per cent of the obese women interviewed in a nutrition clinic reported untoward emotional responses to previous attempts at weight reduction. Such symptoms as "nervousness," "weakness," "irritability," "fatigue," and "general dissatisfaction" were prominent.

A more detailed investigation of 25 obese women in a psychosomatic clinic revealed that 9 had suffered emotional disturbances of psychotic intensity during past and present attempts at weight reduction. A common feature of these patients was a particularly intense relationship to one person, who was seen as the source of all love and security. Interference with this relationship, particularly when this interference was voluntarily chosen by the patient, appeared to be a precipitating factor in many of these illnesses. Such a development often occurred during a period of elation ushered in by some apparently favorable change in the patient's living. It was in this setting that the ill-fated dietary attempts were undertaken. The period of elation was terminated abruptly when some frustration forced the patient to recognize her vulnerability in her isolated situation. This led to a period of intense anxiety, which was followed by a prolonged depressive spell. Recovery to the premorbid adjustment occurred in each case, and the illness apparently left no lasting ill-effects.

DISCUSSION

DR. HILDE BRUCH: It is a pleasure to discuss an excellent paper, but it leaves the discussant somewhat out on a limb. There is not much I can add, except to underline some of the main points.

By implication, Dr. Stunkard stated that it is necessary to recognize that obesity is a far from uniform disorder and that obese people show wide differences in their reaction to dieting. Conflicting opinions on the treatment of obesity are due to the failure to recognize these differences and to generalize, instead, from one particular case to all cases. Dr. Stunkard's group consists of women who were selected from the nutrition clinic because they were unable to cooperate in a diet program. The psychological significance of "poor cooperation" has been recognized before, and there are many individual reports of successful psychiatric work with such patients. The shortcoming of this older work is the very fact that it deals with isolated cases usually carefully selected for their suitability for analysis. The merit of the present study is that it has been carried out on a sufficiently large number to illuminate certain common factors in a group of obese women who had in common this seemingly irrational behavior of complaining about being too fat but then refusing to do anything about it. It has been recognized by others that it is futile, even harmful, to enforce a reducing program under those circumstances.

**Chlorpromazine Therapy in Private Practice: Its Benefits and Complications.** DR. STANLEY LESSE, DR. SIDNEY MALITZ, and DR. PAUL H. HOCH.

This study is a survey of 150 patients treated over a period of one and a half years. Diagnostically, there were 68 patients with schizophrenia, 40 with involutional melancholia, 33 with psychoneuroses, and 9 with organic psychoses. One of every five showed marked improvement. If only those patients who demonstrated marked anxiety prior to therapy were included, about one in every three showed marked improvement. The degree of overt anxiety is the main factor determining the degree of improvement. The greater the initial anxiety the better the expectations for improvment. The diagnostic entity does not seem to be a point of importance. In general, the briefer the illness the better the results. The initial daily dose varied from 50 to 400 mg. The total daily dose was as high as 1500 mg. Improvement usually was noted during the first two weeks of treatment. Exacerbations, when they occurred, usually did so during the first three months.

Electroshock therapy was helpful in 34 of 58 patients in whom chlorpromazine had failed. Combined electroshock-chlorpromazine therapy was helpful in a few patients in whom each

treatment alone had failed. About half of the patients had adverse effects from the drug. In 21 patients the drug was stopped because of the severity of the side-reactions. The commonest complications were drowsiness, dryness of the mouth and nose, pruritis, Parkinson-like patterns, and grip-like syndromes. Jaundice occurred in six cases. No agranulocytosis was seen.

DISCUSSION

DR. NATHAN S. KLINE: I am lost in admiration of Dr. Lesse, Dr. Malitz, and Dr. Hoch for the expedition and thoroughness with which they have managed to test a very sizable group of patients in private practive in a relatively short time. This constitutes a real contribution to the literature. Normally it would take a much greater length of time for a series of this size to accumulate in private practice.

There is one question which stands out in the whole presentation: What would have happened to these patients if they had been treated with psychotherapy alone?

I disagree with the authors on only one point in the paper, and that is that the results here given could not have been predicted from hospital patients. It could not have been known with certainty a priori that private patients would respond as do the hospitalized ones, but, on listening to this paper, one finds that the results reported are almost identical with responses to both reserpine and chlorpromazine in institutional patients.

I think the most valuable contribution of the paper is the clear statement of the value of combined shock and chlorpromazine. It is a strong indication that shock is not to be discarded arbitrarily.

DR. STANLEY LESSE: I would like to thank Dr. Kline for his comments. I do not agree with him that there is not much difference in many instances between hospitalized patients and those seen in private practice. In general, there is a considerable difference between the type of patients we treated in our series and those reported from the state hospitals.

**Arteries of the Brain: An Anatomic Study.** DR. HARRY A. KAPLAN.

A concept of a uniform pattern of arteries throughout the brain has been derived from a six-year study of the blood vessels of slightly over 500 brains. Stereoroentgenograms of whole specimens and flat films of serial slices of fresh cadaver brains, in which the blood vessels were injected with a radiopaque material, made possible a study of the distribution, course, and ramification of vessels in an undistorted relationship to surrounding structures. A constant relationship of the cerebral arteries to specific vesicles of the neural tube exists. The basic arterial pattern is essentially the same in design, consisting primarily of central perforating and lateral surface vessels, arising from a main ventral trunk.

# Abstracts from Current Literature

EDITED BY DR. BERNARD J. ALPERS

## Physiology and Biochemistry

ELECTROPHORETIC AND CHEMICAL SERUM PROTEIN FRACTIONS IN MULTIPLE SCLEROSIS. A. SAIFER, A. M. RABINER, I. ORESKES, and B. W. VOLK, Am. J. M. Sc. **225**:287 (March) 1953.

Because of evidence of abnormalities of the proteins of the blood serum and spinal fluid in patients with multiple sclerosis, electrophoretic protein fractions of 23 patients with multiple sclerosis were studied. There were markedly lowered albumin and A/G ratio values in 87% and increased $\beta$-globulin in 74% and $\alpha_2$-globulin values in 65% of the cases. The $\gamma$-globulin fraction was usually slightly above the normal mean value. In all cases the $\beta$-globulin fractions were above and the A/G ratios below the mean normal value.

Other protein flocculation tests were simultaneously investigated. The cephalin-cholesterol flocculation test was positive in 66% of the patients with multiple sclerosis. The thymol turbidity test was positive in 30%, and the zinc sulfate turbidity test in 20%, of the cases of multiple sclerosis. All of these findings applied equally to patients in a state of remission and those with exacerbation of their illness.

BERLIN, Mount Vernon, N. Y.

ANTIMETABOLITES OF SEROTONIN. D. W. WOOLLEY and E. SHAW, J. Biol. Chem. **203**:69, 1953.

Several 3-alkyl-5-amino indoles proved to act as antimetabolites to serotonin when measured on ring segments of carotid arteries. The antagonistic effect is competitive. This observation is of interest because of the finding of serotonin in brain and the mental states elicited by the serotonin antagonist *d*-lysergic acid diethylamide.

PAGE, Cleveland.

ASSOCIATION OF HEXOKINASE WITH PARTICULATE FRACTIONS OF BRAIN AND OTHER TISSUE HOMOGENATES. R. K. CRANE and A. SOLS, J. Biol. Chem. **203**:273, 1953.

Ninety per cent of the hexokinase activity of rat and calf brain homogenates is associated with the particulate fraction which is sedimented at 18,000×g. The particulate matter treated with lipase and desoxycholate results in a forty-five- to fifty-fold increase in specific activity of the hexokinase. Glucose-6-phosphate, in low concentrations, inhibits the hexokinase from brain, while crystalline yeast hexokinase is not so inhibited.

PAGE, Cleveland.

INACTIVATION OF VOLUNTARY MOTOR FUNCTION FOLLOWING RHIZOTOMY. A. LASSEK, J. Neuropath. & Exper. Neurol. **12**:83 (Jan.) 1953.

The purpose of this investigation was to determine the defects produced by total brachial rhizotomy in the monkey. Such a procedure abolishes all of the incoming general sensory impulses, including the afferents from muscles, and provides an opportunity to study how the motor cortex and other motor cells may react in their absence.

Lassek found that the dorsal roots to an extremity, in their entirety, play a significant role in the over-all performance of voluntary motor function ramifying into all phases: movement, tone, and reflexes. When they are sectioned, severe and enduring deficits result, characterized by an almost complete loss of all purposeful movements. Flaccidity is a predominant feature, and many reflexes, including the postural, are affected. Impulses coursing over this system seem to have a "priming" effect on motor cells within the central nervous system, without which initiation and direction of motor phenomena are impossible.

The author believes also that the dorsal root system, *in toto*, plays an important part in ontogenetically training upper and lower motor neurons to function normally and in the restitution of function and production of spasticity following lesions of the central nervous system.

ALPERS, Philadelphia.

AN INVESTIGATION OF OLFACTORY CENTRIFUGAL FIBER SYSTEM. D. I. B. KERR and K.-E. HAGBARTH, J. Neurophysiol. **18**:362 (July) 1955.

Kerr and Hagbarth studied the centrifugal paths to the olfactory bulb of the cat by observing the effects of their excitation upon the resting electrical activity of the olfactory bulb and that induced in the bulb by olfactory stimulation. Depressive influences were evoked by exciting the basal rhinencephalic area (prepyriform cortex, cortical amygdaloid nucleus, and olfactory tubercle) and by high-frequency stimulation of the anterior commissure. These influences are believed to be mediated through centrifugal fibers of the anterior commissure which terminate upon the granule cells of the bulb. The depressive influences are manifest either as a reduction of the spontaneous discharge in the bulb or as a reduction or an abolition of the recurrent waves induced by olfactory stimulation. There is indication that the influence may be a tonic one.

Low-frequency excitation of the lateral olfactory tract and the anterior commissure caused discharges in the bulb and augmentation of induced olfactory activity. Since the lateral olfactory tract lacks centrifugal fibers, these observed effects are attributed to antidromic excitation of known recurrent collaterals of this tract. It is not known whether the similar results of anterior commissure stimulation can be attributed to antidromic activity.

The findings provide further indications for central regulation of afferent transmission within the nervous system.

SIEKERT, Rochester, Minn.

EFFECT OF NICOTINE ON SPINOCEREBELLAR ATAXIA. J. D. SPILLANE, Brit. M. J. **2**:1345, (Dec. 3) 1955.

Spillane gives detailed reports of four patients with spinocerebellar ataxia in whom tobacco smoking increased the severity of the ataxia of the lower extremities, and in two of whom it made the dysarthria worse. The same effects were reproduced on all four patients by the intravenous injection of nicotine acid tartrate. Spillane attributed these adverse effects to "some action of nicotine on the central nervous system which may involve disturbance of synaptic transmission of nerve impulses." Tobacco smoking and intravenous injection of nicotine had no deleterious effects on 8 other patients with progressive spinocerebellar degeneration and none on 20 patients having various organic diseases of the brain and spinal cord.

ECHOLS, New Orleans.

## Neuropathology

HISTOLOGICAL CHANGES WITHIN THE CHOROID PLEXUS OF THE LATERAL VENTRICLE: THEIR RELATION TO AGE. J. DUNN JR. and J. W. KERNOHAN, Proc. Staff Meet. Mayo Clin. **30**:60 (Dec. 14) 1955.

Dunn and Kernohan studied the choroid plexus of the lateral ventricle in 324 brains obtained at necropsy and noted regressive changes which were associated with age. These changes did not appear to affect the primary physiological function of the choroid plexus in its production of spinal fluid. The ages in this series ranged from birth to 100 years, and sections from the choroid glomus were studied histologically in each case with only the hematoxylin and eosin stain.

The covering ependymal cells of the choroid plexus were of a low columnar to cuboidal epithelium in most cases, with definite evidence of flattening in the older age groups. Flattening of the covering cells was related directly to increasing amounts of connective tissue and to formation of hyaline plaques within the villi. A true columnar epithelium was found in only four cases of children who were less than 10 years of age. No evidence of cilia was found in any of the preparations, and the authors believe that cilia are found only in freshly prepared specimens of very young persons. Vacuoles were found in the ependymal cells of all the plexuses examined, and fat stains readily demonstrated the presence of fat within the vacuoles. The deposition of lipids within the vacuoles was one of the most significant changes noted with increasing years. The authors also noted an increase in fibrocollagenous elements. Clusters and sheets of arachnoidal cells were found within the central stroma about the large arteries and veins but never within the stroma of a villus. Psammoma bodies were not found within the fibrous stroma of the villi, and their origin appeared to be almost entirely from clusters of arachnoidal cells. Typically, calcification begins centrally within the laminated cluster of cells, and the arachnoidal cells may be found in varying stages of hyaline and fatty degeneration. It also appeared likely from their observations that condensation of fibrous reticulin served as a nidus for future

lamination and growth of the mature psammoma body. The vascular changes associated with age consisted of internal thickening and medial fibrosis.

The authors conclude that the regressive changes occur frequently and increase with age, although they were not limited to any given age.

MANDEL, Philadelphia.

## Meninges and Blood Vessels

THE INTRACRANIAL BRUIT. I. MACKENZIE, Brain **78**:350, 1955.

An intracranial bruit is not encountered frequently; but when it does occur, it may be of diagnostic help, although it does not necessarily indicate the presence of a pathological lesion. With the history of trauma, pulsating exophthalmos, and evidence of damage to nearby structures, the finding of a bruit is hardly necessary to establish a diagnosis of a caroticocavernous fistula. A cephalic bruit, usually heard over the eye, may be the one constant sign in arteriovenous fistulas without trauma. In cases of focal epilepsy and migraine, with or without abnormal signs, the presence of a bruit will almost always indicate a diagnosis of intracranial angioma, although meningiomas or vascular gliomas may sometimes cause a bruit. In the presence of subarachnoid hemorrhage, as a presenting finding, the presence of bruit is found more frequently with ruptured aneurysms than with angiomas. Mackenzie emphasizes that a bruit in childhood may have no pathological basis, and in patients aged 8 to 14 the bruit may be caused by compression of normal vessels at the base of the brain rather than by an increased blood flow.

Mackenzie reports 11 cases in which an intracranial bruit was heard and notes that the bruit was associated with many pathological conditions, including cerebral angioma, meningioma, carotid aneurysm (congenital and traumatic), tumor of the glomus jugulare, carotid occlusion, pinealoma, and cerebral thrombophlebitis (both in children). He postulates that when a bruit is heard in association with an angioma or a vascular tumor, it originates just beyond the point where the artery carrying an increased blood supply undergoes a relative stenosis. This probably explains why bruits are best heard over the eyeball, regardless of the precise location of the angioma, provided that they are supplied by an internal carotid artery. This may also explain why a bruit is not a constant feature of even the largest angiomas. In the case of an aneurysm causing a bruit, it is suggested that the aneurysmal dilatation upon neighboring bony structures is sufficient to propagate audible impulses.

MANDEL, Philadelphia.

THROMBOSIS OF THE BASILAR ARTERY WITH SOFTENINGS IN THE CEREBELLUM AND BRAIN STEM DUE TO MANIPULATION OF THE NECK. FRANK R. FORD and DAVID CLARK, Bull. Johns Hopkins Hosp. **98**:37 (Jan.) 1956.

In 1947 Pratt-Thomas and Bergh published an article dealing with three cases in which death followed chiropractic manipulations. Two of these cases are identical in all features with the two cases which are the subject of this report. The first patient was a man of 32 who died 24 hours after the manipulation. There was no cervical fracture and no damage to the cervical cord. Postmortem examination revealed thrombosis of the basilar artery, the left anterior inferior cerebellar artery, and the right posterior inferior cerebellar artery. The second patient was a woman of 32 who died a few hours after manipulation. There was no fracture or dislocation of the cervical spine and no injury of the cervical cord. Postmortem examination revealed thrombosis of the basilar artery, the right vertebral artery, and the left posterior inferior cerebellar artery, with softenings in the cerebellum.

The purpose of this paper is to describe two cases which emphasize the danger of excessive rotation of the head. The first case was a man of 37 who developed signs of damage to the brain stem immediately after his wife twisted his head. The course was progressive, and he died about 60 hours later. Roentgenograms of the cervical spine revealed no evidence of dislocation or fracture. The basilar artery appeared to contain two thrombi. There also appeared to be thrombi in the left posterior cerebral artery and in the left posterior inferior cerebellar artery. On section of the brain, the only abnormality found on inspection was a small hemorrhage, about 1 cm. in diameter, in the white matter of the left cerebellar hemisphere. Microscopic examination revealed loss of cells and small areas of partial softening in the white matter of the left cerebellar hemisphere. Only a few small areas of partial softening were found in the white matter of the right half of the cerebellum. The anatomical changes were less destructive than one might have expected.

The second patient was a man of 41 who was manipulated by a chiropractor. He lost consciousness at once and later was found to have signs of damage to the right side of the pons. About 10 years later the signs and symptoms had persisted.

This syndrome would seem to be a well-defined one, for in all four of these cases the essential features are the same. No dislocation or fracture of the cervical spine was found in roentgenograms or at necropsy. It must be concluded that the injuries were due not to simple direct trauma but to interruption of the circulation.

Vascular disease does not seem to play any role in these cases. In the three cases in which postmortem examination was performed the arteries were always normal.

In all cases the symptoms followed manipulation of the neck. The symptoms developed immediately, and it does not seem possible that a thrombosis could develop so suddenly. The initial symptoms must have been due to occlusion of an artery by some mechanism. No doubt, the thrombus formed later and may well have played an important role in the final result.

Excessive rotation at any joint may result in angulation, stretching, or compression of arteries. It is possible that spasm of the arteries might result. Rotation of the head occurs chiefly at the joint between the axis and the atlas, where it has been estimated a movement of 25 degrees is possible. No doubt the damage is done at this level. There is some reason to believe that excessive rotation at this point is easily carried out only in persons whose odontoid ligaments are too lax or easily ruptured.

ALPERS, Philadelphia.

OBSERVATIONS ON THE ORIGIN OF MENINGIOMA FROM THE CHOROID PLEXUS OF THE LATERAL VENTRICLE. J. DUNN and J. W. KERNOHAN, Proc. Staff. Meet. Mayo Clin. **31**:25 (Jan. 11) 1956.

In a previous study, Dunn and Kernohan reported regressive changes in the choroid plexus which occurred with age, and consisted principally of an increase in the number of arachnoidal cells with psammoma bodies, as well as proliferation of fibrous stroma. A striking similarity was noted between these regressive changes and meningothelious meningiomas.

The authors review two cases of meningiomas in older persons which arose from the choroid plexus of the lateral ventricle and demonstrate by histological examination that these tumors, which were meningothelious meningomas, were of arachnoidal-cell origin. They postulate that proliferation of the arachnoidal cells may be directly related to the formation of meningothelious meningiomas, whereas the origin of the purely fibroblastic meningioma is from the fibrous component of the stroma of the plexus.

MANDEL, Philadelphia.

## Diseases of the Brain

CENTRAL APHASIA ASSOCIATED WITH PARIETAL SYMPTOMS. E. STENGEL and I. C. LODGE PATCH, Brain **78**:401, 1955.

The syndrome of central aphasia is characterized by an incomplete receptive aphasia, modified by impairment of the patient's ability to focus attention to word sounds produced by others and inability to repeat sentences. Stengel and Patch report three cases of central aphasia in which the speech disorder was associated with symptoms indicative of involvement of the parietal area of the dominant hemisphere, a Gerstmann syndrome being found in all three cases. In addition, there was evidence of logorrhea, with numerous paraphasias and some inability to name objects. The transverse temporal gyrus and parietal lobes were involved in these cases, the parietal lobe lesions being verified by autopsy and by biopsy. The parietal lobe involvement was considered significant of the patient's inability to repeat phrases and sentences. The syndrome of central aphasia is therefore considered to be the result of a combination of a lesion in the superior temporal gyrus with extensive damage of the neighboring parietal area.

MANDEL, Philadelphia.

CERTAIN DISTURBANCES OF ATTENTION ASSOCIATED WITH ORGANIC CEREBRAL DISEASE. M. REINHOLD, Brain **78**:417, 1955.

Human behavior, thinking, and development depend upon the awareness of sensations. The term attention describes a state of increased awareness of sensation, which is a qualitative experience of a conscious person. The physiological events which accompany or precede sensation

are the reception, transmission, differentiation, and integration of sensory stimuli. The response to sensory stimuli involves the subjective qualitative experience of the subject, which cannot be measured by objective means. The response to sensory stimuli is also dependent upon other factors, one of which is attention. Conscious persons may not perceive certain sensations because they are attending to other sensations. Attention is generally initiated psychologically, and, as a result, certain physiological events occur in the nervous system. If some damage to the nervous system interferes with the physiological processes, the patient may have a disturbance of attention which will prevent him from isolating that particular experience of sensation.

Reinhold reports on two patients with disturbances of attention as a result of neoplasms—the tumor occurring in the parietal area of the dominant hemisphere, in one case, and in the temporoparietal area of the major hemisphere, in the second case. A meningioma was removed in the first case, and a metastatic carcinoma of the lung was found in the second. Both cases illustrate interrelated physiological and psychological aspects of perception with disturbances of attention. The author suggests that sensory stimuli evoke patterns of nerve impulses which are fragmented, differentiated, circulated, and reintegrated throughout the nervous system. Thus, a complex relationship is achieved with all patterns of nervous activity already present in the nervous system and those which follow as a result of further stimuli.

The physiological patterns of nervous activity form the basis for a psychological aspect of perception, namely, the judgment of sensory relationships. According to the theory, attention involves the isolation of one or more patterns of nervous activity and active judgment of sensory relationships. Certain factors influence attention, such as the number of stimuli applied at any time and repetition of stimuli. Impairment in attention may therefore be caused by physiological, as well as psychological, factors. It is also suggested that attention is an aspect of the human tendency toward unity or integration of function.

MANDEL, Philadelphia.

THE STATUS VERRUCOSUS OF THE CEREBRAL CORTEX. I. BERTRAND and J. GRUNER, J. Neuropath. & Exper. Neurol. **14**:331 (Oct.) 1955.

Status verrucosus of the cerebral cortex is characterized by imperfect convolutions, usually small. It is rare, and Bertrand and Gruner report observations on five specimens. They date the disturbance to the fifth fetal month.

In extreme cases the fissures of first order and smaller sulci lose their normal configuration and small irregular, incomplete, and atypical gyri are heaped one against the other all over the surface of the hemispheres ("cauliflower brain"). In less pronounced cases a few isolated warts are seen. The involvement may be focal or diffuse.

Two elementary histologic configurations are seen in various combinations: (1) The "festoon" type, which modifies the cortex throughout its depth, consists of gentle curves of cortical neurons, the normal layers being absent; and (2) the "status verrucosus" type proper consists of disorganization of the superficial cortical layers. The subcortical white matter is hypoplastic, and the courses of the fiber bundles are disturbed. The piarachnoid shows discontinuity, condensation, and invasion by cortical elements. The arrangement of the blood vessels is markedly abnormal, with small arteries forming a net over the cortex and an intramolecular meshwork.

Idiocy, motor disturbances, retarded development, and convulsive seizures may be present, depending on the extent of the pathologic process.

SIEKERT, Rochester, Minn.

ABSCESS OF CAVUM SEPTUM PELLUCIDUM. R. A. HUGHES, J. W. KERNOHAN, and H. W. WOLTMAN, Proc. Staff Meet. Mayo Clin. **30**:536 (Nov. 16) 1955.

Abscess of the cavum septi pellucidi is extremely rare. The authors report a case in a 32-year-old man who entered the hospital because of pneumococcic meningitis. He developed signs and symptoms of increased intracranial pressure and died four days later.

Gross examination of the brain revealed a tense, fluctuant mass in the region of the rostrum of the corpus callosum, which upon sectioning was found to contain 25 ml. of thick yellow pus. This mass was in the cavum septi pellucidi, which did not appear to communicate with the ventricular system. Microscopic examination revealed the lining of the cavity to be ragged in contour, and it was covered with debris. The exudate consisted of plasma cells, small lymphocytes, eosinophiles, and a few polymorphonuclear cells, but no bacteria could be seen. Moderate endothelial proliferation was noted, as well as a collection of round cells about the vessels.

It was not possible to ascertain whether the abscess was secondary to the meningitis or primary in the cavum septi pellucidi. The abscess may have resulted from septicema or an infected embolus to one of the vessels in the wall of the septum pellucidum.

MANDEL, Philadelphia.

HEAD INJURY AS A CAUSE OF INTERNAL CAROTID THROMBOSIS. C. B. SEDZIMIR, J. Neurol. Neurosurg. & Psychiat. **18**:293 (Nov.) 1955.

Sedzimir reports six cases of injuries to the head which were thought to be responsible for the development of thrombosis of the intracranial segment of the internal carotid artery. An analysis of these cases reveals that in each instance the main impact to the skull was frontal, and in two cases examined after death a fracture of the floor of the anterior fossa was found in close proximity to the intracranial segment of the internal carotid artery. From an anatomical standpoint, the thrombus in the internal carotid artery was found adherent to the wall of the artery at its point of emergence from the cavernous sinus, and it is at this site that the carotid siphon may show some variation. Apparently, the artery is subjected to shearing strains at this point; and if the artery is already arteriosclerotic, the trauma may well be a precipitating factor in the causation of the thrombosis. In younger persons the same mechanism may induce spasm which may simulate a thrombosis clinically, as well as angiographically.

The commonest site of internal carotid thrombosis is in the neck distal to the carotid sinus; however, in these cases of intracranial thrombosis, the clot may spread proximally to the region of the bifurcation.

Clinically, in these cases, in the presence of focal signs exploration for a subdural hematoma may be carried out, but only recent necrosis or atrophy may be found. In some cases after head injury, the thrombosis may be evident almost immediately; but in other instances such findings may not be evident for weeks, months, or years after the trauma had either been discounted or forgotten. This condition must therefore be considered in distinguishing the etiologic factors in cranial trauma.

MANDEL, Philadelphia.

## Peripheral and Cranial Nerves

SENSORY NEUROPATHY ASSOCIATED WITH CARCINOMA OF THE OESOPHAGUS. M. C. H. DODGSON, and H. L. HOFFMAN, Ann. Int. Med. **38**:130 (Jan.) 1953.

Up to the present time two histologically proved cases of carcinomatous sensory neuropathy have been recorded (Denny-Brown). In both of these, and in the other cases of pure spinal neuropathy, reported by Wyburn-Mason and Lennox and Prichard, the growth was invariably in the bronchus. The case reported here suggests that a similar neuropathy may be associated with carcinoma in other sites.

Dodgson and Hoffman describe a case of sensory neuropathy in a 54-year-old white man occurring in association with carcinoma at the upper end of the esophagus.

The mode of production of sensory neuropathy is still unknown. The available evidence seems to suggest that carcinomatous neuropathy arises as the result of a metabolic disorder, for the production of which a carcinoma is responsible. There is also the possibility that sensory and other neuropathies in association with malignant disease indicate the invasion of the nervous system by a virus.

ALPERS, Philadelphia.

## Treatment, Neurosurgery

BELL'S PALSY TREATED WITH CORTISONE. H. H. ROTHENDLER, Am. J. M. Sc. **225**:358 (April) 1953.

Because Bell's palsy may be a result of nerve compression produced by nonspecific inflammatory changes, cortisone was used in the treatment of seven patients with this condition. Treatment was started from 1 to 10 days after the onset of the paralysis and was continued for 10 to 14 days. In all but one case improvement started in 1 to 5 days and complete recovery occurred in from 7 to 12 days after cortisone treatment was begun.

BERLIN, Mount Vernon, N. Y.

STUDIES IN CEREBROVASCULAR DISEASE: V. USE OF ANTICOAGULANT DRUGS IN THE TREATMENT OF INTERMITTENT INSUFFICIENCY OF THE INTERNAL CAROTID ARTERIAL SYSTEM. C. H. MILLIKAN, R. G. SIEKERT, and R. M. SHICK, Proc. Staff Meet. Mayo Clin. **30**:578 (Nov. 30) 1955.

The authors report seven cases of intermittent insufficiency of the internal carotid arterial system which were treated by long-term administration of bishydroxycoumarin (Dicumarol). The patients were carefully selected upon the basis of neurological history and examination, and some patients demonstrated significant changes in the ophthalmodynamometer reading on the involved side. After the use of anticoagulant drugs the attacks ceased. The number of these patients who would have suffered thrombosis of the internal carotid artery had anticoagulants not been given is not known, but the authors advocate the use of bishydroxycoumarin to prevent the possibility of cerebral infarction in such instances. In one case, bishydroxycoumarin was used in the presence of the occluded vessel because of continuing episodes of insufficiency, and in the hope that it would prevent further embolic formation. The exact duration of anticoagulant therapy during the course of arterial insufficiency is not known, although the authors believe a "long-term" course is advisable.

The pathogenesis is thought to be the formation of a thrombus upon an area of diseased epithelium, which increases in size to produce alteration in the blood flow, causing symptoms. The new clot, however, may become dislodged before symptoms occur and travel to a branching of the vessels, where it finally lodges, fragments, and is then carried away.

MANDEL, Philadelphia.

## Encephalography, Ventriculography and Roentgenography

THE RELATION OF THE CAPACITY OF THE HUMAN SKULL TO ITS ROENTGENOLOGICAL LENGTH. I. L. MACKINNON, Am. J. Roentgenol. **74**:1026 (Dec.) 1955.

MacKinnon measured the volume of 52 dry adult skulls by filling them with lead shot. Roentgenograms were made of each skull with a measuring bar, perforated at 1 cm. intervals, suspended from the film at the same distance as the midline of the skull. Thus, the true lengths of the skull could be measured accurately from the glabella to the opisthocranion. It was found for the average skull that the ratio of the capacity of the skull, in cubic centimenters, to the length of the skull, in centimeters, was 78 to 1. The capacity of any skull in cubic centimeters, can be estimated by multiplying its length, in cubic centimeters, by 78. The greatest difference between the estimated and the true capacity of any one of the 52 skulls examined was 17%.

WEILAND, Grove City, Pa.

PHYSIOLOGIC VERTEBRAL LIGAMENTOUS CALCIFICATION: AN AGING PROCESS. C. F. SMITH, D. G. PUGH, and H. F. POLLEY, Am. J. Roentgenol. **74**:1049 (Dec.) 1955.

Smith, Pugh, and Polley describe a calcification of the longitudinal ligaments of the spine which is seen not infrequently by radiologists but which has not been described often in the radiological literature. The authors use the term "physiologic ligamentous calcification" to describe the process and to differentiate it from a disease process, although they admit that the calcification may not strictly be a physiological phenomenon. The roentgenograms and case records of 53 patients studied between 1946 and 1951 were reviewed. All these patients exhibited the roentgenologic finding of calcification in the longitudinal ligaments of the spine, and in no case was it thought likely, either clinically or from examination of the roentgenograms, that the patients had rheumatoid arthritis of the spine. Of the 53 patients, 21 had no symptoms referable to the back, and 32 patients had pain or stiffness in the back. The thoracic portion of the spine was found to be the most frequent site of involvement in the 53 cases studied. If the calcification was found in the lumbar or cervical region, the thoracic region almost always was also affected. The ligamentous calcification in some patients covered the entire length of the spinal column, whereas in others it extended for only one or two vertebral interspaces. The thickness of the calcified ligament shadow on the roentgenograms was from 5 to 10 mm. in the more advanced cases. The calcified ligament is usually homogeneous in density and is distinct from the anterior margin of the vertebra to which it is attached. The vertebrae are of normal density and frequently show hypertrophic changes. The calcification almost always occurs in patients more than 50 years of age. In most of these patients the sacroiliac joints appeared normal.

Physiological ligamentous calcification can be confused radiologically with both rheumatoid spondylitis and osteoarthritis of the spinal column. The advanced age of the patients in whom physiological calcification is found, the relatively late age of onset of symptoms in some cases, the absence of symptoms in other cases, the absence of involvement of the sacroiliac joints, and the absence of some systemic indications of rheumatoid arthritis should differentiate physiological calcification from this disease. Smith, Pugh, and Polley feel that physiological calcification can be differentiated radiographically from osteoarthritis, since osteophytes should be distinguished from calcification in the ligaments without difficulty.

WEILAND, Grove City, Pa.

ANGIOGRAPHY IN THE EVALUATION OF INTRACRANIAL TRAUMA. J. E. LOFSTROM, J. E. WEBSTER, and E. S. GURDJIAN, Radiology **65**:847 (Dec.) 1955.

Lofstrom, Webster, and Gurdjian give their impressions based on approximately 500 carotid arteriographic studies which they have performed in cases of suspected intracranial injury. They also have attempted to simulate subdural hematomas by injecting vegetable shortening into the epidural space of the skulls of cadavers. Subsequently, radiopaque material was injected into the cerebral arterial system, and the displacement of the arteries by the vegetable shortening was studied in roentgenograms of the skulls. It was found that the displacement of the arteries produced experimentally corresponded rather closely to that produced by subdural hematomas in living patients.

Lofstrom and his associates believe that cerebral angiography should be used more widely in cases of suspected head injury. It is more accurate in localizing subdural or intracerebral masses of blood than is ventriculography, electroencephalography, or neurological examination. In many patients with acute head injury a history of trauma cannot be obtained because the trauma is incidental to alcoholism, a cerebrovascular accident, or other conditions producing stupor or coma. The lateralization and localization of the lesion provided by cerebral angiography are very helpful in deciding upon surgery and in planning an adequate surgical approach.

WEILAND, Grove City, Pa.

# Books

**Etiology of Chronic Alcoholism.** Edited by Oskar Diethelm. Price, $6.75. Pp. 240. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1955.

In a book which combines the work of many disciplines, chronic alcoholism is considered from a broad, integrated point of view. The varied possible approaches to research in chronic alcoholism are dealt with in an introductory chapter by the editor, Oskar Diethelm. Dr. Mary Sherfey discusses the psychopathology and character structure of these patients and produces material confirming the observations of others that the symptom of alcoholism may be associated with any psychiatric condition.

An illuminating and valuable chapter by Freile Fleetwood on experimental laboratory investigations ties up biochemical factors with the emotions of anxiety, agression, and resentment in alcoholic patients. This bears further exploration. There are two chapters by Manfred Bleuler, one on familial considerations and the other a comparative study of differences between Swiss and American alcoholics. An anthropological study by Milton Barnett of alcoholism in the Cantonese of New York City completes this valuable volume.

This comprehensive approach to a massive problem is an important contribution. It points out the complexities one must consider in attempting to deal with alcoholics from the investigative, clinical, and social points of view. It is recommended to social and clinical personnel caring for alcoholic patients, who must be prepared to face up to the fact that alcoholism is a major health problem, requiring much more intensive study as to cause and treatment.

**Energy and Structure in Psychoanalysis.** By Kenneth Mark Colby. Price, $4.50. Pp. 154. Ronald Press Company, 15 E. 26th St., New York, 1955.

Colby attempts to integrate psychoanalytic theory into the more general field of theoretical science. He does this through the utilization of the terminology of modern physical science to describe the phenomena of psychic activity. The major problem which he faces is the explanation of directional aspects of psychic activity. The organization of perceptual material, the processing of thought material, and the determination of the course of activity are all approached in terms of movements of psychic or cathectic energy. Colby constructs a cyclic-circular model to portray the directional system of mental activity. This structural system represents his attempt to solve the basic dilemma of all psychic theories based upon pure energy postulates. In some types of theoretical physical systems, structural limitations and entropy considerations will, taken together, permit prediction of directional changes. Statistical mechanical movements are codified in the second law of thermodynamics. However, Colby rejects the second law as being without application to open biological systems. This he does in spite of the considerable biochemical literature of recent years in this area. He therefore must find some other basis for direction. Thus, dynamic homeostasis cannot be considered as spontaneous self-stabilization around points of metastability. Rather, with his rejection of the probabilistic implications of the second law and his failure to utilize servomechanism theory, he views the concept of homeostasis as purely descriptive and completely without mechanistic connotations.

Colby attempts to give purpose to the psychic machine by the postulation of a structural complex which limits and determines the potential mobilities of psychic energy. The structural complex consists, in a sense, of various one-way roads and expressways which delineate the pathways which otherwise nondirectional psychic or any biological energy must follow. This cyclic-circular model represents the major thesis of the book. This system of speculation is certainly most interesting and provocative. It attempts to solve the problems inherent in the multidimensional freedom of motion inherent in a psychic or biological energy machine through the restriction of such freedom imposed by the structural component.

The model consists of ten macrosystems, each of which is composed of extremely large numbers of microcomponents, or schemes. Seven of the macrosystems lie horizontally, while three lie vertically in a three-dimensional manifold. The entire system is intraconnected to form a circular whole. The vertical components are a transveyor system, a percept-relinker system,

and a thought-relinker system. The horizontal components are a sensory system, a receptor system, a proprial system, an environal system, a lingual system, an emitter system, and a motor system.

Freud faced a similar problem in his system of psychic energy. He attempted solution through essentially the same device, a structural model. His was the tripartite model of id, ego, and superego. Colby's book contains no indication that his model is superior to that of Freud for the description of psychic phenomena. It is unfortunate that he attempts to justify the use of his system in preference to that of Freud on the basis that his is more consistent with modern physical theories and with modern scientific philosophy. Nowhere in this book does he establish a relationship with modern physical systems. While it is true that he draws frequent analogies to the terminology of modern science, the terms and concepts of modern science are usually applied completely out of context to their physical meanings. Thus one gains from these considerations the superficial and unwarranted impression that this model system is in truth based upon and closely related to modern physical theory.

A few brief examples will make this clear. Colby's chapter on psychoanalytic metapsychology points out that his entire theory of instincts and drives (directional units) is based upon a consideration of "forces representing energy quanta."

Forces can never be considered in either modern or classical physics as representing energy quanta. Force and energy are dimensionally different things, with different units. Force is represented dimensionally as a first-power distance function [mass $\times$ distance/(time)$^2$], while energy is represented physically as the corresponding second-power distance function [mass $\times$ (distance)$^2$/(time)$^2$]. Thus force is vectorial, while energy is scalar. Colby further states: "By energy we mean psychic energy, a postulated form in addition to known mechanical, thermal, electrical, and chemical forms."

The absence of dimensional units for his psychic energy function is in keeping with his unitless interpretation of modern physics. This is pointed out in his statement that "contemporary physical theories of energy state that it is simply a number at one end of an equation" (page 26). This quotation suggests scientific naïveté on the part of the author. This may to some degree explain the absence from this book of considerations of philosophical problems in modern physics which do have implications relative to psychoanalytic theory.

In spite of the above criticisms for lack of scientific rigor, the book would still be of value if it crystallized and organized psychological theory with a resultant over-all simplification with or without new insights. This also Colby does not do. If anything, he complicates the subject matter. The theory gives no new explanations, suggests no new approaches for empirical research, and permits no avenue for proof or disproof. However, some justification does exist if the author finds his system useful. Its eventual value will depend upon whether or not other workers also find it fruitful.

**The Psychiatrist: His Training and Development.** Report of 1952 Conference on Psychiatric Education, Ithaca, N. Y. Price, $2.50. Pp. 214. American Psychiatric Association, 1785 Massachusetts Ave., N.W., Washington, D. C., 1953.

The continued evolution of ideas concerning the training and education of a psychiatrist and the development of well-integrated residency training programs on a national scale depend largely on the type of conference held in Ithaca, N. Y., in 1952, and the publication of its transactions. There have been tremendous spurts of growth and shifting emphases in this field in the past decade, very well reflected in this official report and supplemented by the recent formulation issued by the Group for the Advancement of Psychiatry.

Almost the only point on which everyone agrees is that the competent psychiatrist must have a basic understanding of the psychodynamics of personality development; how he comes by this understanding is the source of continued controversy. The first work of this conference was to attempt some coordination of viewpoints on the broad concepts of psychodynamic principles, particularly to close the unnecessarily wide gap between the genetic-dynamic formulations of the Meyerian school and the psychoanalytic concepts of the Freudian school. The only point upon which general agreement could be reached at the time of the conference was that "psychodynamics is concerned with understanding the motives of human behavior"; beyond this simple expression of ancient psychological truth, nothing more specific regarding theories of motivation, basic concepts of "special mechanisms," and their practical application in diagnosis or therapy

could apparently be resolved. Thus, it appears that there are wide diversity of opinion and considerable dissatisfaction in general with the most fundamental principles that are being taught in American psychiatry today, and with the way in which these principles should be taught to the embryo psychiatrist. Certainly, the most challenging and provoking section in this Conference report is the Report of the Special Commission on Psychodynamic Principles, which should be read in its original by every serious student of psychiatry.

In an effort to provide less rigid, "spoon-fed" types of training programs, some centers have apparently departed considerably from the widely accepted routine of introducing residents immediately into inpatient psychiatry; although there is general agrement as to what the resident should learn in his three years, there is considerable disagreement as to how he should learn it and in what order. The Conference opinion was strongly in the direction of providing at least one year (preferably the first) of work with inpatient psychiatry, with the opportunity for the resident to study and observe a wide variety of patients, and at the same time begin to enter the field of intensive psychotherapy with a few selected patients under careful supervision. There was also general agreement that analytic training, if undertaken, should be deferred at least until after the first year of training.

The chapter on the resident is noteworthy because of its omissions. Discussion of selection of residents and qualifications for entering the field of psychiatry was not as detailed as the importance of those subjects would merit. The difficulties of determining what makes a good candidate for psychiatric residency are universal and obvious, but certainly more attention should be directed toward setting up a study involving hindsight in an effort to determine at least what has made a bad resident, why he failed, and what might have indicated that he would fail. The intricate machinery involved in weeding out failures and the methods of handling them during residency are among the most urgent unsolved problems and need more airing in conferences such as this one. More attention is paid to the problem of resident selection in the recent report of the Committee on Medical Education of the Group for Advancement of Psychiatry.

The controversial subject of the role of psychoanalysis in residency training was handled in a separate chapter, as well as the role of child psychiatry. A surprising unanimity of opinion was voiced on three of the questions regarding psychonanalysis, viz., that "it is not necessary to be psychoanalyzed in order to develop competence as a psychiatrist, including competence in psychotherapy and psychodynamics"; that "it is highly desirable that some persons should receive a personal psychoanalysis and psychoanalytic training. . . and for those who are to practice the specialty of psychoanalytic therapy, such psychoanalytic training is considered a necessity; and that it is impossible to be empirical in all cases about when this training should be undertaken." The actual inclusion of some sort of training in child psychiatry for the general psychiatrist was thought to be necessary, but there was no agreement as to the timing; there is considerable objection to the idea of introducing child psychiatry too early in the residency program, and many thought the third year was the best time. However, it seemed that the idea of not assigning a specific block of time to child psychiatry was a popular one and that work with a small number of child patients over a longer period of time was preferable.

The remainder of the report concerned the special problems of the relation of psychiatry to other specialties, special fields within psychiatry, and the national mental health picture. There is an excellent appendix and much good reference material in this report. A more concise statement regarding similar problems is to be found in the recent report of the Group for Advancement of Psychiatry Committee on Medical Education, entitled "Trends and Issues in Psychiatric Residency Programs."

John Whitehorn and his associates are to be congratulated on the groundwork of this conference, as well as on making available this readable and comprehensive report on its discussions. There is every reason to continue and extend the work of this committee toward the end of resolving many of the unsettled problems of the residency training program. There is certainly enough diversity in the already well-established residencies in this country to enable a study group to draw some conclusions regarding the relative efficacy of certain varying routines. Many topics could be suggested for further study, such, for instance, as the length of the training period, how many years of training it should take to produce a mature and competent practicing psychiatrist, and what factors should influence us in making this choice. Should there be a difference in the length of time it takes to train a good child therapist, or an industrial consultant, or an institutional administrator? Should we give significant consideration to the financial needs of physicians in this crucial period of life, when many of them are faced with the demands of a growing

family, the establishment of a home and community life, and perhaps personal needs in the form of psychotherapy or personal analysis? The special needs of embryo psychiatrists perhaps should be reviewed especially in relation to training programs in other specialties, such as surgery, pediatrics, obstetrics, etc. Most graduate education administrators are loath to admit any special consideration in an over-all program, and generally attempts are made to equalize resident stipends so that no specialty group is favored. Public awareness of the tremendous problems of mental health in this country has recently taken an amazing surge forward; it is timely, perhaps, to focus more on methods of attracting better men to this field, beginning in medical school, and on increasing and bettering the facilities for the production of competent and well-trained psychiatrists. At the same time, it is well to consider the dangers of overspecialization, overtraining, and "spoon feeding" for the majority of residents who are planning, with increasing frequency, to settle in moderately large urban communities to do a sort of "general practice" of psychiatry, with emphasis on the use of psychotherapy in the treatment of common neurotic disorders. It is to be hoped that this sort of problem could provide the focus for further conference discussion patterned after the 1952 Ithaca conference.

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1. Silverman, M.: J. Ment. Sc. *101*:640 (July) 1955.